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Perceptions of Neighborhood Safety:

Influence on Engagement in Physical Activity by Mothers and Children

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Perceptions of Neighborhood Safety:

Influence on Engagement in Physical Activity by Mothers and Children

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Dedication

To my husband Vicente Guerrero, whose worth is beyond measure.

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Perceptions of Neighborhood Safety:

Influence on Engagement in Physical Activity by Mothers and Children

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Overweight and obesity are major public health concerns. These conditions are preventable through healthy diet and engagement in physical activity (PA). This study builds on existing work around the influence of perceptions of neighborhood safety on (PNS) engagement in PA. The Geographic Research on Wellbeing study includes survey data from a diverse sample of 3016 California mothers with 4-10 year old children. Structural equation modeling was used to test a multivariate assessment of PNS through confirmatory factor analysis and to test relationships between household and neighborhood level socioeconomic position (SEP), availability and safety of neighborhood parks, and children's and mothers' PA, mediated by PNS. Exploratory analyses tested the models with social cohesion as a mediator.

In the children's model, neighborhood SEP was not related to children's PA. PNS partially mediated the relationship between household SEP and children's PA and fully mediated the relationship from park availability/safety to children's PA. PNS was not directly related to mother's PA. An exploratory model testing social cohesion as a mediator performed similarly to PNS in the children's PA model. In the exploratory model for mothers' PA, relationships between household SEP, neighborhood SEP and crime to PA were partially mediated by social cohesion, and the relationship between parks and PA was fully mediated by social cohesion. While the models fit well, prediction of PA was limited. The PNS and social cohesion models predicted ~4.5% of the variance in children's PA, and the social cohesion model predicted 8.3% of mothers' PA. Therefore the results of this study may have limited practical significance.

This study concluded that PNS performed well as a multivariate construct. Comprehensive definitions of PNS provide more information to studies of children's PA than the often used single-dimension assessments. Results of this and other research suggest PNS is an important buffer for the effects of SEP and park access on PA among children. For mothers and children in this study social cohesion was positively associated with PA and did mediate paths from other individual and neighborhood indicators to PA. Neighborhood-level interventions to improve social cohesion are indicated to increase engagement in PA.

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List of Acronyms and Abbreviations

BMI	Body Mass Index
CDC	Centers for Disease Control and Prevention
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
GROW	Geographic Research on Women Study
HSEP	Household Socioeconomic Position
MIHA	Maternal Infant Health Assessment
NHANES	National Health and Nutrition Examination Survey
NSEP	Neighborhood Socioeconomic Position
PA	Physical Activity
PNS	Perceived Neighborhood Safety
RMSEA	Root Mean Square Error Approximation
SEM	Structural Equation Modeling
SEP	Socioeconomic Position
TLI	Tucker-Lewis Index
χ^2	Chi-square
YRBSS	Youth Risk Behavior Surveillance Survey

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Chapter 1: Background and Rationale

Overweight and Obesity in Children and Mothers

Introduction

The purpose of this chapter is to provide definitions of overweight and obesity and explain the prevalence of these conditions among children and mothers in the United States. Physical and mental health outcomes related to overweight and obesity are described. A discussion of racial/ethnic and socioeconomic disparities as well as risk and protective factors is also provided. Current recommendations for physical activity (PA), a primary behavioral determinant of overweight and obesity, and levels of attainment of these recommendations are discussed. This chapter then provides a description of the three research aims addressed by this study and a brief overview of the methods employed in this dissertation. The chapter concludes with a description of the dissertation structure.

Definitions

According to the Centers for Disease Control and Prevention (CDC), overweight is defined as having excess body weight for a particular height from fat, muscle, bone, water, or a combination of these factors (Krebs et al., 2007). Obesity is defined as having severely excess body fat. Body mass index (BMI) is a commonly used measure of healthy weight calculated by dividing an individual's weight by height (kg/m^2).

The National Health and Nutrition Examination Survey (NHANES) is used by the CDC to track the prevalence of overweight and obesity in the United States (Ogden, Carroll, Kit, & Flegal, 2014). The CDC defines overweight for children ages 2-19 as having a BMI in the 85th to 95th percentiles of the sex-specific CDC BMI for age growth charts (Kuczmarski, Ogden, & Guo, 2002). Children are defined as obese if they have a BMI at or above the 95th percentile (Ogden et al., 2014). Adults with a BMI of 25-29.9 are defined as overweight, and adults with a BMI greater than 30 are considered obese.

The biological mechanism of overweight conditions is due to the imbalance of energy intake and expenditure; individuals gain weight when the calories consumed exceed energy expended. Risk factors for energy imbalance occur at the individual, family, social, economic, and environmental ecological levels. Factors contributing to energy imbalance in the human body, even with small effects, can contribute to obesity in the long term (Ebbeling, Pawlak, & Ludwig, 2002).

Obesity and Overweight in Children

Outcomes. Childhood overweight and obesity are associated with a host of adverse physical and psychological health outcomes (Vivier & Tompkins, 2009), and significant health care and social costs (Cawley & Meyerhoefer, 2012). Childhood obesity leads to increased risk of disease, including cardiovascular diseases, type 2 diabetes, hypertension, and orthopedic complications in children and adolescents (Dietz, 1998; Reilly et al., 2003; Vivier & Tompkins, 2009). Children who are obese are more likely to retain that status into adulthood, especially if they are obese at older phases of childhood (Dietz, 1998; Whitaker, Wright, Pepe, Seidel, & Dietz, 1997). The

psychosocial impacts of childhood obesity include stigmatization, lower self-esteem, and poorer quality of life (Schwimmer, Burwinkle, & Varni, 2003; Vivier & Tompkins, 2009), as well as a higher likelihood of mental health problems compared to non-obese children (Reilly et al., 2003). In addition to these substantial impacts on individual health and well-being, childhood obesity takes a toll on medical expenditures in the United States, accounting for over $14 billion annually in estimated health-care costs (Cawley, 2010).

Prevalence. The prevalence of obesity and overweight in United States children and adolescents is disturbingly high. The latest NHANES survey (2011-2012) found 31.8% of US children 2-19 are obese or overweight; 16.9 % of these meet criteria for obesity (Ogden et al., 2014). This recent data from NHANES suggest that the increase in the prevalence of obesity and overweight in children is leveling off. Prior to this leveling off, the prevalence of obesity among children aged 2–17 years increased significantly from 15.4% to 18.6% among boys and non-significantly from 13.8% to 15.1% among girls between 1999–2002 and 2007–2010 (May, Freedman, Sherry, & Blanck, 2013).

NHANES data also demonstrate that racial/ethnic and socioeconomic disparities in childhood obesity and overweight exist (Ogden, Carroll, Kit, & Flegal, 2012); among children ages 2-19, prevalence of overweight is highest among Hispanic and non-Hispanic Black children (38.9% and 35.2% respectively), compared to non-Hispanic Asian (19.5%) and White (28.5%) counterparts. The same is true for obesity prevalence, where 22.4% of Hispanic children and 20.2% of non-Hispanic Black children meet obesity criteria, compared to children who are non-Hispanic Asian (8.6%) and White

(14.1%) (Ogden et al., 2012). Educational attainment of the adult head of household is inversely associated with childhood obesity according to NHANES data from 1999-2010 (May et al., 2013), and the prevalence of obesity among children whose head of household had not completed high school is approximately twice as high as the prevalence among children whose head of household had a college degree.

In California, levels of childhood overweight and obesity are slightly higher than national averages: 31.8 nationally (Ogden et al., 2014) compared to estimates of 33.8 to 36.7% at the state level (detailed below) (Aryana, Li, & Bommer, 2012; Koebnick et al., 2012). State-level estimates of childhood overweight and obesity are available for many states through the Youth Risk Behavior Surveillance Survey (YRBSS), however, California data are not made available as the response rate is less than 60% (Centers for Disease Control and Prevention, 2014b). Individual research studies from other sources provide estimates of childhood overweight and obesity in the state. A 2007-2009 cohort study of 920,000 children ages 2-19 enrolled in a healthcare management organization in Southern California found 36.7% of the children met the NHANES criteria for overweight and obesity (17.4% and 19.2% respectively) (Koebnick et al., 2012). California does universal fitness and body composition testing of all 5^{th}, 7^{th} and 9^{th} graders enrolled in public schools (Babey, Wolstein, Diamant, Bloom, & Goldstein, 2011). A study of these data from 2003 to 2008 (n=8.4 million) found 33.3% of the students met the NHANES criteria for overweight or obesity (10.1% overweight, 16.3% obese) in 2003 and 35.4% (17.4% overweight, 17.9% obese) in 2008 (Aryana et al., 2012). In a study of the same data in 2010, the percentage of children who were

overweight or obese was 38.4% (Babey et al., 2011), suggesting an increasing trend in prevalence.

Causes, Risk and Protective Factors. Child overweight and obesity are affected by various genetic, behavioral, and environmental factors (Daniels et al., 2005), including physical and social aspects of children's neighborhoods (Davison & Lawson, 2006; Sallis & Glanz, 2006) (Davison & Lawson, 2006; French, Story, & Jeffery, 2001; Lee & Cubbin, 2002; Sallis & Glanz, 2006; Sallis, Prochaska, & Taylor, 2000). For instance, children and families in urban neighborhoods with lower socioeconomic position (SEP) have less access to affordable, fresh and healthy food sources (French et al., 2001). They also have fewer spaces for play, more traffic and more exposure to crime and violence (Sampson, Morenoff, & Gannon-Rowley, 2002) compared to families with higher SEP, which may cause parents to limit neighborhood-based play and exercise (Carver, Timperio, & Crawford, 2008). Neighborhood social and environmental conditions appear to be of particular importance in understanding ecological contributors to obesity and overweight through families' ability to engage in adequate levels of PA.

Physical Activity (PA) in Children: Importance, Definitions, Standards and Current Levels of Attainment. As mentioned previously, PA is an essential component of maintaining a healthy weight; when children do not expend enough energy through PA compared to their caloric intake, they gain weight through caloric imbalance. Ensuring US children attain adequate levels of PA is a primary public health concern (US Department of Health and Human Services, 2013). In addition to maintaining healthy weight, PA in childhood is also essential for proper physical development of muscles and

bones and psychological well-being (Physical Activity Guidelines Advisory Committee, 2008). It is also related to better academic performance and better behavior in academic settings (Centers for Disease Control and Prevention, 2010). The CDC (2011) recommends at least 60 minutes a day of PA for children, while the American Academy of Pediatrics suggests that even more PA (>80 minutes daily) may be necessary for some children to maintain healthy weight (Strong et al., 2005).

The results of data from nationally representative surveys show that many children are not participating in adequate daily PA. Data from NHANES found 42% of children ages 6-11 and 8% of adolescents ages 12-19 are meeting the 60 minutes/day guideline when measured by accelerometer (Troiano et al., 2008). The CDC's Youth Media Campaign Longitudinal Study (2002-2006) found that child participation in daily PA (7 days / week) declined over a 4-year period as the children aged from 9-13 to 13-17 years. Participation in daily PA was lower than 51% for both boys and girls at all ages at each annual measurement (Wall, Carlson, Stein, Lee, & Fulton, 2011). Similarly, the 2011 Youth Risk Behavior Surveillance System survey of youth in grades 9-12 found that 49.5% of children meet the 60 minute criteria for 5 days in the previous week and only 28.7% meet the criteria for 7 days during the previous week (Eaton et al., 2012).

Population-based estimates of children's time investments in physical activity in California are unavailable. Although physical activity is not measured, universal programs underway in California public schools measure physical fitness in 5th, 7th and 9th grade (Babey et al., 2011). These programs, as mentioned previously, have not yet created measureable change in students' BMIs. However, significant improvements in

aerobic capacity and overall fitness scores were measured from 2003 to 2008, with just over one-third of students (34.8%) able to achieve all of 6 fitness goals in the school-based program in 2008, up from 28.9% in 2003 (Babey et al., 2011).

Obesity and Overweight in Mothers

Outcomes. The outcomes of obesity for adult women are as concerning as those for children. A host of physical health outcomes are correlated with obesity in adult women, including type 2 diabetes, coronary heart disease, high blood cholesterol and high blood pressure and osteoarthritis (Must et al., 1999; Pi-Sunyer, 1993), as well as certain types of cancer (National Institutes of Health, 1998). Many of these outcomes lead to a web of co-morbidities and premature death, and longer obesity duration is correlated with higher all-cause mortality (Abdullah et al., 2011). Obesity poses additional risks to mothers and babies during pregnancy, including pre-eclampsia, gestational diabetes, a cesarean section delivery and babies who are large for gestational age. (Athukorala, Rumbold, Willson, & Crowther, 2010). Infants who are large for gestational age and/or exposed to gestational diabetes are at increased risk of metabolic syndrome leading to increased risk for obesity (Boney, Verma, Tucker, & Vohr, 2005)

In addition to physical health outcomes, women who are overweight or obese often face associated emotional and mental health challenges. Self-esteem can be greatly affected, as American society is a "hostile cultural climate" for women who are overweight or obese (Devlin, Yanovski, & Wilson, 2000, p. 854). Too much body weight may contribute to depression through increased difficulty with physical activity (Devlin et al., 2000; Simon et al., 2008). For women receiving treatment for mental

health problems, overweight and obesity can be made worse through some drug treatments, as weight gain is a common side effect (Devlin et al., 2000).

Prevalence. As with children, prevalence of overweight and obesity in adults remains high. According to data from the 2012 Behavioral Risk Factor Surveillance Survey (BRFSS) , more than a third (34.9%) of US adults are obese, totaling nearly 78 million individuals (Centers for Disease Control and Prevention, 2014a). This is nearly identical to the 2009-2010 NHANES survey, which found the age-adjusted prevalence for obesity was 35.5% for males and 35.8% for females (Flegal, Carroll, Kit, & Ogden, 2012) In California, 25.1% of adults report being obese on the 2012 BRFSS (Centers for Disease Control and Prevention, 2014a). Although the state is the 11th least obese in the US, as in other states across the US, California saw an alarming rise in obesity prevalence from the mid-1980's to 2010, which seems to now be leveling off.

Racial and economic disparities in adult obesity persist. While obesity has increased across all income levels, in women, NHANES data from 2005-2008 shows obesity is negatively associated with income (Ogden, 2010) and less educated women are more likely to be obese compared to those that have a college degree. Additionally, women with lower socioeconomic position may experience increased depression and lower physical activity, leading to higher prevalence of overweight and obesity (Beydoun & Wang, 2009). The 2009-2010 NHANES found that 34.4% of Non-Hispanic White women were overweight or obese, compared to 49.5% of Non-Hispanic Black women, and 39.1% of Hispanic women (Flegal et al., 2012)

PA in Mothers: Importance, Recommendations and Current Levels of Attainment. Physical activity is an essential component of a healthy lifestyle. There are a number of health benefits associated with participation in regular and adequate PA, including the prevention of weight gain that can lead to overweight and obesity (US Department of Health and Human Services, 2008). Adults engaged in adequate levels of PA have lower risk of coronary heart disease, stroke, high blood pressure, type 2 diabetes and some kinds of cancer (US Department of Health and Human Services, 2008). PA also contributes to prevention of falls, better cognitive function and reduced depression. A reciprocal link between depression and obesity has been confirmed in reviews of several cohort studies: obesity increases the risk of depression, and depression is predictive of developing obesity (Luppino, de Wit, Bouvy, & et al., 2010).

The Physical Activity Guidelines for Americans provided by the US Department of Health and Human Services suggest that adults obtain, at minimum, 150 minutes a week of moderate-intensity physical activity, 75 minutes a week of vigorous-intensity PA, or a combination of the two (US Department of Health and Human Services, 2008). Ideally, according to the guidelines, adults will engage in 300 minutes a week with additional muscle strengthening activities 2 days each week or more.

As with US children, most adults are not meeting the minimum recommendations for physical activity. In an evaluation of NHANES data from 2005-2006, researchers found a large difference between self-reported PA (average of 324 minutes/week of moderate PA and 74 minutes of vigorous PA) and PA measured by accelerometer (45 minutes per week of moderate PA and 19 minutes of vigorous PA) in a sample of 3082

adults who completed both accelerometer and self-report measures (Tucker, Welk, & Beyler, 2011). According to the study findings, less than 10% of US adults are meeting minimum PA guidelines when PA is measured objectively by accelerometer.

Problem Statement

Overweight and obesity are major public health concerns for both children and adult women in the United States. These health conditions contribute to serious and potentially life-limiting medical sequelae and mental health problems, but they can be prevented through proper nutrition and engagement in adequate levels of PA. Most women and children are not meeting minimum recommendations for PA (Centers for Disease Control, 2011; Tucker et al., 2011; US Department of Health and Human Services, 2013), despite the many physical and mental health benefits. There is a need to better understand factors that contribute to PA in children and mothers in order to reduce barriers to engagement and prevent overweight and obesity.

Study Introduction

Overview

Given that overweight and obesity are major public health issues for the United States, and that neighborhood-level factors are important influences on the preventive activities, such as PA, that are associated with curbing these conditions (Bauman et al., 2012; Bedimo-Rung, Mowen, & Cohen, 2005; Bellows-Riecken & Rhodes, 2008; Carver et al., 2008; Cradock, Kawachi, Colditz, Gortmaker, & Buka, 2009; Foster & Giles-Corti, 2008; Gómez, Johnson, Selva, & Sallis, 2004; Greves Grow et al., 2010; Luppino et al., 2010; May et al., 2013; L. H. McNeill, M. W. Kreuter, & S. V. Subramanian, 2006b;

Weir, Etelson, & Brand, 2006), this dissertation research investigates the contributions of neighborhood-level factors to children's and mothers' PA. In particular, this study focused on perceived neighborhood safety (PNS), which is related to participation in PA in neighborhood settings, but has not yet been fully understood (Baum, Ziersch, Zhang, & Osborne, 2009; Beets & Foley, 2008; Burdette & Whitaker, 2004; Carver et al., 2008; Carver, Timperio, Hesketh, & Crawford, 2010; De Jesus, Puleo, Shelton, & Emmons, 2010; Gómez et al., 2004; Miles, 2008; Pitner, Yu, & Brown, 2012; Rundmo, 1996; Weir et al., 2006; Wood et al., 2008; Ziersch, Baum, MacDougall, & Putland, 2005). This dissertation addressed three research aims:

(Aim 1) To determine if a multi-factorial conceptualization of maternal PNS – as opposed to the singular approaches predominate in the literature - is supported,

(Aim 2) To examine the potential mediating role of PNS in the pathways between neighborhood and household socioeconomic conditions, park availability/safety and children's PA, followed by an examination of the role of child gender as a potential moderator of these relationships, and

(Aim 3) To examine the potential mediating roles of PNS and social cohesion in the pathways between neighborhood and household socioeconomic conditions, park availability/safety and mothers' PA.

Brief Summary of Methods

Summary. This research involves secondary data analysis of data from the Geographic Research on Wellbeing (GROW) study. The study employs structural equation modeling (SEM) in Mplus to conduct a factor analysis on PNS, and then to

obtain a measurement model and test a full structural model of children's and mothers' PA within a multilevel mediation analysis. The full structural model is also re-analyzed with child gender groups to determine if gender moderates the structure for children's PA.

The GROW Study. GROW is a survey conducted in 2012-2013 with a 6-county subset of the participants in the 2003-2007 Maternal and Infant Health Assessment (MIHA), a statewide-representative cross-sectional mail and telephone survey conducted annually in California with mothers shortly after they gave birth. The dataset includes measures of many neighborhood and individual characteristics, including comprehensive assessments of SEP at both levels, and measures of children's and mothers' PA, from a sample of over 3,000 mothers. The GROW sample is socioeconomically and ethnically diverse and representative of the mothers giving birth in the California counties included in the study during the survey period.

In contrast to other studies that only use census data to describe neighborhood conditions, the GROW survey also provides:

- Geocoded participant data that is linked with built environment characteristics
- The participant's subjective assessment of neighborhood conditions
- A specific focus on mothers
- Mothers' assessments of child PA and report of own PA using a novel, validated item (Kiernan et al., 2013)

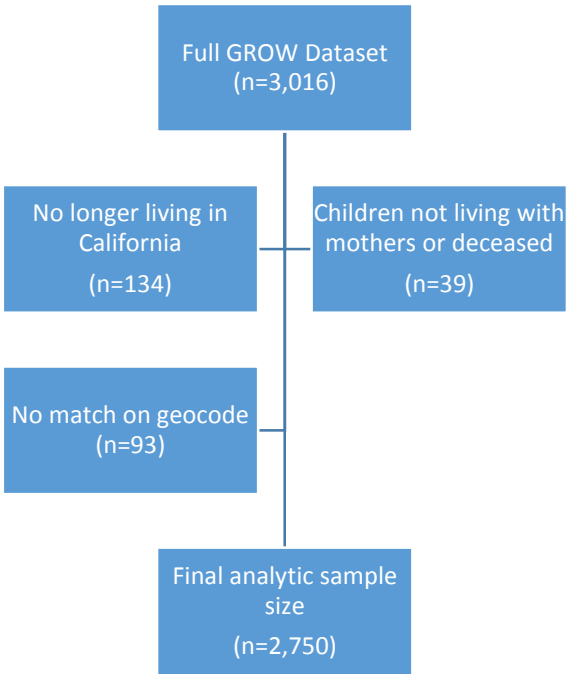
Inclusion Criteria for MIHA and GROW Surveys. The MIHA survey included a representative sample of California mothers delivering live infants from February to May annually from 2003-2007. Eligible mothers were English or Spanish speaking, aged 15 or older, with single, twin or triplet births, and an address provided on the birth certificate. The mothers received the MIHA survey approximately 10-14 weeks after giving birth. Participation in GROW, a follow-up study to MIHA, was offered to all mothers who participated in MIHA from a six-county region (Alameda, Los Angeles, Orange, Sacramento, San Diego, and Santa Clara counties) who could be located.

Sampling. The sample for MIHA was selected using a stratified random sampling method. Mothers were stratified by region and then by race, oversampling African-American mothers. The data are weighted for non-response, oversampling and post-stratification. With weighting, the sample is representative of all mothers who gave birth in California during the MIHA study period. All mothers who participated in MIHA in the specified six-county region were invited to participate in GROW, and respond to questions about the same child who was born at MIHA (i.e., index child). Out of 9,256 eligible mothers from MIHA, 4,026 were located and invited to participate in GROW. A total of 3,016 (74.9% of the mothers who were located) completed the survey.

Study Inclusion Criteria. For this research, some participants were excluded from the study analyses. The GROW dataset contains 3,016 cases. The focus of this research is neighborhood-level influences on health among California mothers and children; thus, participants who moved out of California after participating in MIHA

(*n*=134) were excluded. In addition to being out of the state, neighborhood-level measures were not collected for these participants. Mothers whose children who were not living with them at least half of the time or whose children were no longer living were also excluded (*n*=39). An additional 93 participants had inaccurate geocodes for their home address and were excluded. The final sample size for remaining analyses was 2,750 (Figure 1.1).

Figure 1.1 Exclusion criteria and final sample size infographic



Variable Changes. Weights could not be calculated for 16 cases because these women moved into the GROW counties after they had given birth; these respondents were given a weight of 1. The values for median household income and median housing value at the neighborhood level (census tract) were divided by 100,000 so that Mplus could accommodate the variance associated with these large numbers, as Mplus prefers that the variance values for all variables in the model are similar. Mothers' age was also divided by 10 for the same reason.

Statistical Software. Datasets for GROW and selected variables from the American Community Survey, 2005-2009, were merged in SAS. The merged dataset was imported into IBM SPSS version 22 for descriptive analyses. All other analyses were conducted in Mplus version 7.11.

Descriptive Analyses. Descriptive analyses and frequencies were conducted on each of the variables included in the study. The GROW sample used in this study includes mothers ages 20 – 57 years (mean =37.08, SD=6.6) responding for a child aged 4-10 years (mean = 6.8 years, SD=1.5). Additional participant characteristics are presented in Table 1.1.

Table 1.1 Demographic and Individual-level Socioeconomic Characteristics of GROW participants, *n*=2,750

Variable	Frequency	Weighted %
Mothers' Race/Ethnicity		
Latina	1230	52.8
White	880	24.1
Black	311	6.2
Asian	269	14.4
Other	10	0.6
Missing	50	1.9
Mothers' Education		
Never attended school	15	.7
8th grade or less	228	10.3
Some high school	230	9.9
High school graduate or equivalent	491	21.9
Some college	667	22.9
College Graduate or more	1107	33.8
Missing	12	0.6
Family Structure		
Mother lives with spouse or partner	2274	83.1
Mother not living with a spouse or partner	462	16.4
Missing	14	0.6
Homeownership		
Homeowner	1347	43.7
Does not own home	1371	55.0
Missing	32	1.3
Family Income as a % of Federal Poverty Level		
0-100%	742	31.6
101-200%	480	18.5
201-300%	291	10.3
301-400%	261	8.5
>400%	712	20.7
Missing	264	10.5

Structural Equation Modeling

Structural equation modeling (SEM) is a statistical technique that takes a confirmatory approach to testing causal hypotheses based on a structural theory (Byrne, 2000). SEM is able to include latent variables in statistical models as well as directly observed variables. In this case, a latent variable (mothers' PNS) can be estimated from other variables measured directly by the GROW survey. The extent to which the observed variables contribute to the latent construct is estimated by a confirmatory factor analysis process, and termed the 'measurement model' in SEM. The full structural model allows for specification of the impact of one latent construct on another in a causal structure, which is presented visually.

Mplus, a statistical software package for SEM, is capable of handling datasets with complex designs, such as the weighted stratified random sample utilized in the GROW study. In Mplus the method referred to as TYPE=COMPLEX was used for all analyses, which accounts for stratification and weighting using a sandwich estimator for standard error computations (Muthén & Muthén, 2012).

Research Aims and Significance

The three research aims addressed in this dissertation addressed gaps in the existing literature and add to the public health and social services' understanding of how neighborhood conditions affect children's PA levels. The literature, research methods, results and discussion for each of these aims are described in forthcoming chapters. This section provides an overview of the research aims designed to frame the literature review provided in Chapter 2.

Aim 1. The first aim of this dissertation was to determine if mothers' perceived neighborhood safety (PNS) could be conceptualized as a multivariate concept. Previous research has primarily addressed general assessments or singular aspects of safety, but there are multiple facets of safety that have been shown to influence children's PA, including general safety, safety for play, safety from crime and traffic safety (Ding, Sallis, Kerr, Lee, & Rosenberg, 2011). Additionally, social cohesion has been found to contribute to PNS (Austin, Furr, & Spine, 2002; Baum et al., 2009; De Jesus et al., 2010). Only one previous study has evaluated a multi-faceted definition of PNS (Austin et al., 2002). The current study tested a comprehensive conceptualization of PNS incorporating mothers' perceptions of social cohesion, traffic safety, safety from crime and general safety in a first and second order factor analysis. Structural equation modeling (SEM) was used to determine factor contributions to PNS and allow for adjustment of the PNS measure to ensure acceptable fit to the data and theoretical relevance.

Significance. Current research on PNS does not account for all of the aspects of safety parents evaluate while making decisions about their children's play. The GROW study presented a unique opportunity to test a more comprehensive, multifaceted measure of PNS. The results of this research are useful for future conceptualizations of the variable in research studies and for interventions designed to make neighborhoods safer for children's play and improve children's engagement in PA.

Aims 2 and 3. The second research aim was to examine the potential mediating role of PNS in the pathways between neighborhood and household socioeconomic conditions, park availability/safety and children's PA, followed by an examination of the

role of child gender as a potential moderator of these relationships. The third aim was to examine the potential mediating roles of PNS and social cohesion in the pathways between neighborhood and household socioeconomic conditions, park availability/safety, and mothers' PA.

These relationships and PNS are examined in two full multilevel structural equation models. The models were re-specified and retested based on the fit to the data and theoretical relevance, resulting in theoretical models that may influence future research and intervention design. Additionally, exploratory models examining social cohesion alone as a mediator were also tested.

Previous studies have found that parental PNS may affect girls more than boys (Gómez et al., 2004) and that boys have higher levels of PA (Hinkley, Crawford, Salmon, Okely, & Hesketh, 2008). Thus, the structural equation model for children's PA was also tested for gender invariance, in order to assess differences in the structure for boys and girls.

Significance. This study adds to the literature through the use of a comprehensive assessment of PNS, as opposed to the singular definitions that have been predominate in previous literature. The GROW study also include a uniquely comprehensive set of social and environmental individual- and neighborhood-level variables, including comprehensive measures of neighborhood and individual SEP, which provide a more complete picture of the effects of SEP than many other studies have used (Braveman et al., 2005; Braveman, Cubbin, Marchi, Egerter, & Chavez, 2001). Therefore, this study addresses gaps in the current understanding of individual and neighborhood-level

influences on children's and mothers' PA, which may result in increased attention to interventions that address multiple ecological levels from both social and environmental perspectives. This study also adds to the body of knowledge about how parental assessments of PNS may vary depending on a child's gender, and whether children's PA is differently affected by mothers' PNS based on gender.

Chapter Summary and Conclusion

In summary, overweight and obesity are major concerns for the public health and social service fields. Rates of these conditions are alarmingly high and the health and economic costs are staggering (Cawley & Meyerhoefer, 2012). In addition, economic and racial/ethnic disparities in healthy weight continue to disproportionately impact children and women with lower socioeconomic position (Centers for Disease Control, 2013; Centers for Disease Control and Prevention, 2014a). PA is an essential preventive measure for these conditions and is linked to many positive physical and mental health outcomes for children (Centers for Disease Control, 2011). It is well known that neighborhood social and environmental conditions influence children's participation in PA (Bauman et al., 2012; Ding et al., 2011; Sallis, Floyd, Rodríguez, & Saelens, 2012; Sallis et al., 2000), although the specific mechanisms for this influence remain unclear in the current body of research. The GROW study provides a unique opportunity for research investigating individual and neighborhood-level influences on children's and mothers' PA. The GROW data was analyzed in this dissertation using structural equation modeling in Mplus.

Subsequent chapters in this dissertation provide a detailed review of the literature (Chapter 2) and the methods and results for each of the three research aims exploring the influence of PNS and related concepts on children's and mothers' physical activity (Chapters 3 and 4). Chapter 5 provides a detailed discussion of the study's results, strengths and limitations, and implications for research and practice.

Chapter 2: Literature Review

Introduction

Physical activity (PA) is an essential component of health and, among other health benefits, prevents overweight and obesity (Centers for Disease Control, 2011). This literature review presents the theories and research supporting and framing this research study in three parts. In the first section, theoretical foundations for multiple levels of impact on health, including Social Ecological Theory and Ecosocial theory are discussed. Social Disorganization Theory is also described as it provides a foundation for understanding how perceptions of neighborhood safety and social cohesion impact individual behaviors within a neighborhood context. The second section of this review explicates individual- and neighborhood-level correlates of mothers' and children's physical activity (PA), including socioeconomic position (SEP), social cohesion, actual and perceived crime, and the built environment. The third section of this review examines the concept of perceived neighborhood safety (PNS) and its impact on PA among mothers and children. Historical perspectives on PNS and an analysis of previously used conceptualizations of PNS are provided, as well as a discussion of methodological issues. This chapter concludes with a discussion of how a more comprehensive measure of PNS may be useful in understanding how PNS relates to PA among mothers and children.

Section One: Theoretical Foundations

Social Ecological Approaches to PA

Ecological approaches to health are rooted in the idea that behaviors are affected by multiple levels of influence, as opposed to the medical model, which focuses on overweight as a biomedical issue resulting from energy imbalance and overlooks potential social causes (Allegrante, Marks, & Hanson, 2006). These ecological approaches assume that changes in the social environment produce changes in individuals, and in reverse, that individuals are essential to creating changes in the social environment. The ecological perspective views determinants of health as operating simultaneously at multiple levels (Bronfenbrenner, 1986; Krieger, 2001).

There are a number of different ecological approaches that are applied to identifying contributing factors for health outcomes and informing appropriate intervention strategies. Brofenbrenner, who pioneered the ecological approach in his work on child development, proposes micro-, meso-, exo- and macrosystem levels of influence affecting human behaviors (1979). McLeroy, Bibeau, Steckler & Glanz (1988) propose a social ecological model for health consisting of: intrapersonal factors, interpersonal processes and primary groups (dyads, families), institutional factors, community factors and public policy.

For the purpose of this dissertation, ecological models provide for the basic premise that both individual- and neighborhood–level variables are important influences on health, and that interventions at multiple ecological levels are often necessary for changing health-related behaviors. Systematic reviews examining correlates of PA

confirm multiple levels of influence; for example systematic reviews by Hinkley, et al. (2008) and Sallis, Prochaska & Taylor et al. (2000) used a five-domain social ecological framework to group determinants into categories: (1) demographic and biological; (2) psychological, cognitive, and emotional; (3) behavioral attributes and skills; (4) social and cultural; and (5) physical environmental. A review by Ferreira, et al. (2007) grouped results by multiple levels of environmental influences (micro- and macro-environments). A recent review by Bauman et al. provides an ecological model for predictors of PA across the life course, depicted in Figure 2.1 (2012). This framework is unique in that it includes the impact of genetic and evolutionary factors that may underlie an individual's biological predisposition for PA engagement. Additionally, it includes the life course element, pointing out that experiences with PA in early life, childhood and adolescence are both affected by the ecological framework and have been shown to affect future engagement with PA. Another model for PA that incorporates the built environment is presented in Figure 2.2 (Sallis et al., 2012). This model demonstrates how individuals are nested within larger contexts and provides aspects of the built and policy environments important to improving PA across four domains: recreational, household, transportation and occupation.

Figure 2.1. A 5-Domain Social Ecological Model for PA with Global Context and Lifecourse Perspective (Bauman et al., 2012, p. 259)

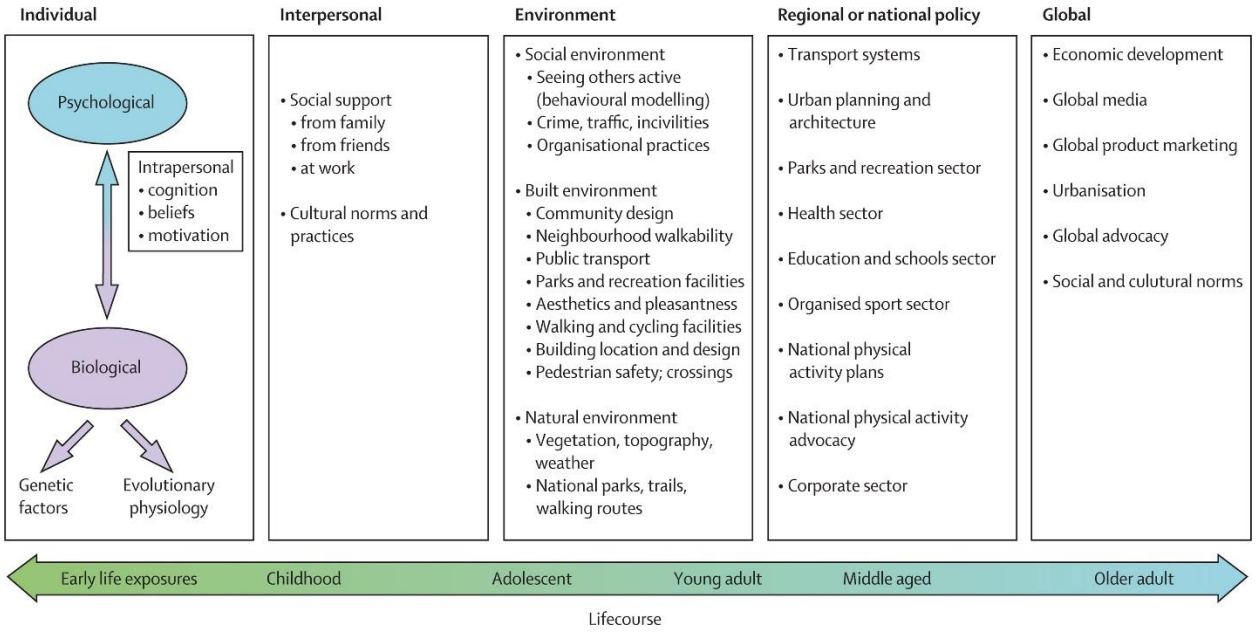
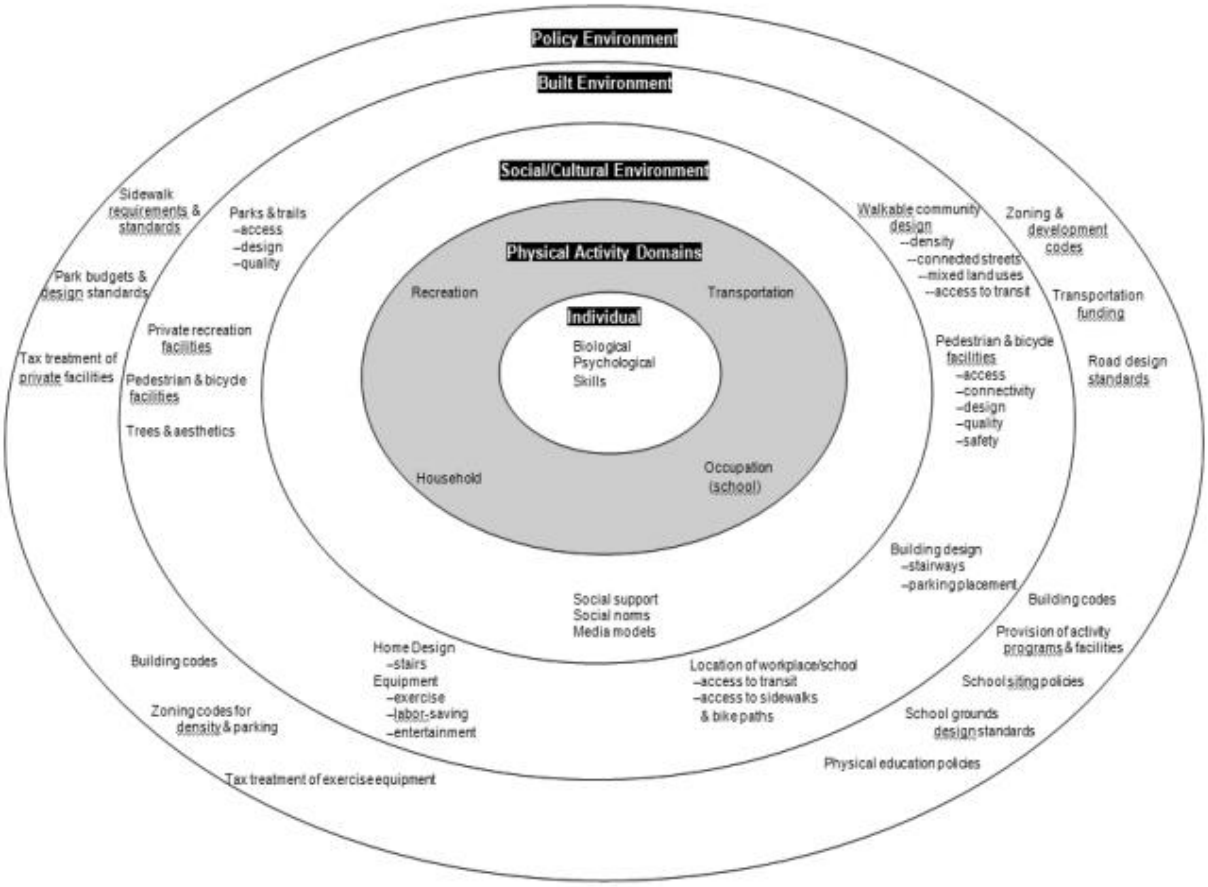


Figure 2.2. A 4-Domain Social Ecological Model for PA (Sallis et al., 2012, p. 730)



Ecosocial Theory

One social ecological theory with particular importance for this dissertation, which evaluates the contributions of individual and neighborhood factors on PA, is Ecosocial Theory (Krieger, 2001). Ecosocial Theory is concerned with a central question: who and what drives current and changing patterns of social inequalities in health? Ecosocial Theory is rooted in a social production of disease perspective and is suited for research concerned with drivers of population distributions of health. Krieger describes four key constructs of the theory (2001, pg. 672) as follows:

1) Embodiment: a concept referring to how we literally incorporate, biologically, the material and social world in which we live, from in utero to death; a corollary is that no aspect of our biology can be understood absent knowledge of history and individual and societal ways of living.

2) Pathways of embodiment: structured simultaneously by (a) societal arrangements of power, property, and contingent patterns of production, consumption, and reproduction, and (b) constraints and possibilities of our biology, as shaped by our species' evolutionary history, our ecologic context, and individual histories—that is, trajectories of biologic and social development.

(3) Cumulative interplay between exposure, susceptibility, and resistance: expressed in pathways of embodiment, with each factor and its distribution conceptualized at multiple levels (individual,

neighborhood, regional or political jurisdiction, national, international or supranational) and in multiple domains (e.g., home, work, school, other public settings), in relation to relevant ecologic niches, and manifested in processes at multiple scales of time and space, and

(4) Accountability and agency: expressed in pathways of and knowledge about embodiment, in relation to institutions (government, business, and public sector), communities, households, and individuals, and also to accountability and agency of epidemiologists and other scientists for theories used and ignored to explain social inequalities in health; a corollary is that, given likely complementary causal explanations at different scales and levels, epidemiological studies should explicitly name and consider the benefits and limitations of their particular scale and level of analysis.

For the purpose of this dissertation, Ecosocial Theory provides for how the conditions of ecologic contexts, in this case, families within neighborhoods, act through the process of embodiment to actually create biologic and social change in children. Additionally it helps to frame how multiple levels of influence on children's PA must be "held accountable" and addressed to positively influence health. In other words, we must change the social structures, settings and policies – not the individual in isolation – to optimize well-being.

Social Disorganization Theory

Social Disorganization Theory (Sampson & Groves, 1989; Shoemaker, 2010) describes how physical incivilities, such as broken windows, graffiti and trash, contribute to social disorganization, which weakens a community's ability to protect itself from crime. Studies have shown the effects of physical incivilities on criminal activity are moderated by the level of social cohesiveness (and related concepts, e.g. social ties and social controls) in a community (Sampson et al., 2002).

Brief Historical Context of Social Disorganization Theory. While investigating patterns of crime in Chicago in the 1920s and 30s, Shaw and McKay found rates of crime committed by juvenile delinquents were concentrated in certain areas of the city, and despite changing populations in these areas, the higher crime rates remained stable over time (Shoemaker, 2010). Using these findings they posited that low economic status, ethnic heterogeneity and residential mobility were disruptive to a community's social organization, which led to increased crime and delinquency (Sampson & Groves, 1989). The theory has been extended by others to include additional mediating concepts, including family disruption and collective efficacy, defined as the willingness and ability of community members to become involved in each other's lives (Sampson & Groves, 1989; Sampson, Morenoff, & Felton, 1999).

Key Concepts. Essentially, according to Social Disorganization Theory, social cohesion and collective efficacy (social organization, also termed social capital) predict whether a neighborhood can realize the values of its residents and maintain effective social controls (Franzini, Caughy, Nettles, & O'Campo, 2008). These constructs are

countered by physical incivilities, which reflect more opportunities for crime and communicated that the level of social cohesion and informal social control is reduced. This set of circumstances creates an environment within which communities cannot develop the formal and informal ties necessary to solve common problems (Shoemaker, 2010). Studies have demonstrated that social disorganization is negatively correlated with children's PA (Molnar, Gortmaker, Bull, & Buka, 2004), while related social cohesion and collectively efficacy are positively correlated (Ferreira et al., 2007)

How social cohesion and other variables work together to form PNS is not yet completely clear, an issue that is compounded as variables are conceptualized differently across research studies. It is clear, however, that the inclusion of multi-level variables is essential (Sampson et al., 2002), as is accounting for both social and physical characteristics of neighborhoods (Austin et al., 2002).

Correlates of PA

Individual-Level Correlates of PA

As described in Chapter 1, although PA is an essential component of a healthy life, over half of children under 19 and the vast majority of adults in the US do not engage in adequate levels of PA (Eaton et al., 2012; Troiano et al., 2008; Tucker et al., 2011; Wall et al., 2011). Some of the most often studied correlates of PA are intra- and inter-personal, including demographic characteristics, familial influence and structure, psychosocial characteristics and household SEP.

Demographic and physical health characteristics. In the US, adult women engage in less PA than their male counterparts (Beydoun & Wang, 2009). The same

gender patter appears to hold among children and adolescents; boys tend to engage in more PA than girls across child and adolescent age groups (Bauman et al., 2012; Biddle, Whitehead, O'Donovan, & Nevill, 2005; Craggs, Corder, van Sluijs, & Griffin, 2011; Hinkley et al., 2008; Sallis et al., 2000; Van der Horst, Paw, Twisk, & Van Mechelen, 2007). White race/ethnicity is a generally associated with higher levels of PA in adolescents (Bauman et al., 2012; Biddle et al., 2005; Sallis et al., 2000) and adults (Eyler et al., 2002; Trost, Owen, Bauman, Sallis, & Brown, 2002) compared with other racial groups. For instance, data from the Youth Media Campaign survey focused on 9 to 13 year old children found that rates of participation in organized sports was negatively associated with parental income and education, and was lower in non-White racial/ethnic groups compared with Whites (Control & Prevention, 2003). Given lower levels of SEP and higher levels of neighborhood socioeconomic disadvantage among populations of color, (Braveman, Cubbin, Egerter, Williams, & Pamuk, 2010; Williams & Jackson, 2005), racial/ethnic disparities in PA may be related to access to parks, recreational facilities and safe forms of active transportation (e.g., walking, biking) (Bauman et al., 2012; Sallis et al., 2012; Sallis & Glanz, 2006).

PA among adults is inversely related to age and positively correlated with health status and previous experience with PA (Bauman et al., 2012; Kaewthummanukul & Brown, 2006; Trost et al., 2002). Additionally, genetics may play a role in whether women and children engage in PA, either through a genetic predisposition to exercise or through a predisposition to overweight or obesity that makes exercise more difficult

(Bauman et al., 2012). Adults who are overweight or obese engage in significantly less PA than those who are of healthy weight (Blanchard et al., 2005).

Family influence and structure. **S**tudies examining parental influence on children's PA have shown mixed results. Parents' own PA was correlated with children's in only 11 of 29 studies reviewed by Sallis et al in 2000. In the Bauman (2012) study of six systematic reviews of correlates to children's PA, only one review, which was focused on young children of pre-school age (Hinkley et al., 2008), found a positive correlation between parents' engagement in PA and children's PA. However, parental and familial support of PA does appear to be important for children, especially as they age into adolescence (Biddle et al., 2005; Edwardson & Gorely, 2010; Sallis et al., 2000; Van der Horst et al., 2007).

Parent's marital status has consistently demonstrated no significant relationship to PA in children (Bauman et al., 2012). Marital status has inconsistent relationships and often insignificant relationships to PA among adults (Allender, Hutchinson, & Foster, 2008; Bauman et al., 2012; Kaewthummanukul & Brown, 2006; Trost et al., 2002). However, when examining the effects of parenthood, parents engage in significantly less PA than non-parents and, as is consistent with the gender disparity identified earlier, mothers get less PA than fathers (Bellows-Riecken & Rhodes, 2008).

Psychosocial characteristics. In terms of mental health, depression is correlated with lower levels of PA in adult women and adolescents and has been shown be a bi-directional relationship (Motl, Birnbaum, Kubik, & Dishman, 2004; Ströhle, 2009). PA is often also related to lower levels of stress and anxiety and better overall mental health

(Ströhle, 2009). The construct of self-efficacy, defined by Bandura as belief in one's own ability to succeed (Bandura, 2001), is a consistent determinant of PA in children and adolescents (Bauman et al., 2012; Biddle et al., 2005; Craggs et al., 2011; Van der Horst et al., 2007), as well as in adults, (Bauman et al., 2012; Kaewthummanukul & Brown, 2006; Trost et al., 2002). Additionally, for adult women, social support is positively correlated with PA (Eyler et al., 1999; Eyler et al., 2002; Sternfeld, Ainsworth, & Quesenberry Jr, 1999; Trost et al., 2002)

Household SEP. At the individual level, limited financial resources restrict access to knowledge, money, prestige and social capital (Link & Phelan, 1995). Household SEP is often measured by variables such as income, marital status and education (Braveman et al., 2005). Systematic reviews of the literature consistently find that household level SEP is inversely correlated with PA in adults and children (Bauman et al., 2012; Dowda, Ainsworth, Addy, Saunders, & Riner, 2003; Trost et al., 2002). Ten years of data from NHANES (1999-2008) reveal that children ages 6-17 from low-income households have a higher prevalence of obesity and sedentary behavior, defined as reporting no PA within the month preceding the survey, than their peers from higher income households (Ali et al., 2011). Other studies of NHANES data have demonstrated positive associations with educational attainment and self-reported PA among adults (Dowda et al., 2003). In studies of adult women, educational attainment is consistently positively related to PA, as found in the review of 91 studies of women by Eyler, et al. (2002).

Neighborhood – Level Correlates of PA

Disadvantaged neighborhood conditions may put residents and their children at risk of poorer health status due to a number of social and environmental factors, including fewer health-supporting services and resources, fewer opportunities for PA (due to safety concerns and decreased walkability), increased stress, greater exposure to acute and chronic disease, and neighborhood violence (Diez Roux & Mair, 2010; Ellen, Mijanovich, & Dillman, 2001; Kawachi & Berkman, 2003; Lee & Cubbin, 2002; Macintyre & Ellaway, 2003). Institutional resources that provide important services and skills (e.g., schools, after-school programs, parks and recreational programs) may also be lacking or of poorer quality in disadvantaged neighborhoods, resulting in compromised access for children and their families (Pebley & Sastry, 2004).

The social ecology of a neighborhood is a vital contributor to the quality of life and health of its residents. Social conditions of a neighborhood, including cohesion, trust, connectedness, and potential for collective action among its residents work together to support or discourage social interactions among neighbors (Kawachi & Berkman, 2000; Pebley & Sastry, 2004; Sampson et al., 2002). Such actions establish a societal structure that may be able to discourage delinquent and unhealthy behaviors (Cradock et al., 2009) and strengthen the community's ability to take action against threats (Sampson, Morenoff, & Earls, 1999; Sampson, Raudenbush, & Earls, 1997). Social cohesion, defined as the extent of connectedness and solidarity in the neighborhood, is of particular importance to health (Macintyre & Ellaway, 2003; McNeill et al., 2006b). A socially

cohesive neighborhood is able to enforce social norms for positive health behaviors and provide tangible support to people within the neighborhood (McNeill et al., 2006b).

Neighborhood-level correlates of PA discussed below include neighborhood SEP, social cohesion, actual and perceived crime and the physical environment. While they are distinct concepts they overlap to form a web of influence on neighborhood-based PA for both children and adults.

Neighborhood SEP. Neighborhood level-SEP has effects on health independent of individual SEP and should be included in health disparities research (Braveman et al., 2005; van Jaarsveld, Miles, & Wardle, 2007). Research consistently indicates that individuals who live in neighborhoods with depressed SEP suffer disparities in health outcomes (Braveman et al., 2010; Cagney, Browning, & Wen, 2005; Ellen et al., 2001; Jencks & Mayer, 1990; Leventhal & Brooks-Gunn, 2000; Pebley & Sastry, 2004; Pickett & Pearl, 2001; Saelens et al., 2012; Steptoe & Feldman, 2001; van Jaarsveld et al., 2007; Weden, Carpiano, & Robert, 2008; Wen, Hawkley, & Cacioppo, 2006; Winkleby & Cubbin, 2003; Winkleby, Cubbin, & Ahn, 2006; Yen, Michael, & Perdue, 2009). Neighborhood SEP is often measured by median family income, rates of homeownership, percentages of families in poverty, educational attainment and/or employment status, among other indicators (Braveman et al., 2005).

Children and mothers in neighborhoods with lower SEP are more likely to be less physically active and demonstrate disproportionately high rates of overweight and obesity than children in mothers in neighborhoods with higher SEP (Gordon-Larsen, Nelson, Page, & Popkin, 2006; Greves Grow et al., 2010; Lee & Cubbin, 2002; Sallis et al., 2012;

Sallis & Glanz, 2006; Sallis, Johnson, Calfas, Caparosa, & Nichols, 1997; Sallis et al., 2000; Stimpson, Ju, Raji, & Eschbach, 2007).

Neighborhood SEP and Obesity. In a 2003 analysis of the National Survey on Children's Health, a study of 102,353 parents of 10-17 year old children, Singh et al. evaluated state and regional disparities in obesity rates in the 50 US states. Individual-level variables accounted for 55% of the variance in state-level obesity rates, while state-level poverty rates contributed an additional 18% of the variance (Singh, Kogan, & van Dyck, 2008). While this study did not measure neighborhood-level variables, it does provide an indication that measures of SEP at broader ecological levels are related to obesity. A study of obesity risk among 8,616 children ages 6-18 in King County, Washington (a large, urban US county) found the risk of childhood obesity to be significantly inversely related to measures of census-tract level SEP, including median household income, home ownership, educational attainment among women, single parent households and proportion of non-White residents, while controlling for parent's insurance type as a proxy for individual-level SEP (Greves Grow et al., 2010). Insurance status is not an ideal indicator of household SEP but it is used frequently in studies of health, especially when medical records are the source of analysis, as they were in this study (Braveman et al., 2005).

Neighborhood SEP and PA. The relationship between neighborhood SEP and PA is not new; the Alameda County study, a longitudinal population-based cohort study of 1,737 adults, looked at change in PA engagement over a 9 year period in the 1960s-70s (Yen & Kaplan, 1998). Change scores were significantly lower for individuals living in

poverty areas than those who were not, independent of a number of individual-level SEP and other health behaviors (e.g., smoking, BMI). The pathways from depressed neighborhood SEP to lower PA attainment and higher rates of overweight/obesity may be partially attributed to disparities in the social and built environments (Gordon-Larsen et al., 2006; A. J. Schulz et al., 2005; van Jaarsveld et al., 2007) (see also the discussion of build environments below). For instance, in a nationally representative study of US adolescents, controlling for race/ethnicity and population density at the census block group level, lower neighborhood SEP measured at the block group level was associated with reduced access to recreational facilities and significantly reduced odds of achieving recommended levels of PA attainment (Gordon-Larsen et al., 2006). In this study, neighborhoods with populations that were 95% non-White and without college education (5% or less) had 46% lower odds of having at least 1 recreation facility compared with neighborhoods with fewer non-white residents and higher levels of educational attainment. Similarly, a national study of commercial PA outlets (e.g., physical fitness facilities, sports clubs, dance studios and golf courses) found that these PA outlets were less likely to be located in lower income neighborhoods and in neighborhoods with higher proportions of non-White residents (Powell, Slater, Chaloupka, & Harper, 2006).

Even when facilities are available, other characteristics of neighborhoods with lower SEP may hamper engagement in PA. For example, in a cross-sectional survey of 1,803 adults in Perth, Australia, respondents in lower SES areas had shorter distances to travel to recreational facilities, but were less likely to use them than respondents in high SES areas because their neighborhoods were busier with traffic, less attractive and

considered less socially supportive of walking (Giles-Corti & Donovan, 2002b). In this study the respondents from lower SES neighborhoods were 36% less likely to engage in vigorous activity.

The type and frequency of women's PA may also vary by neighborhood SEP. A study of data from the Stanford Heart Disease Prevention Program (1979-1990) with linked census and business location information found that women in lower SEP neighborhoods reported greater energy expenditure but engaged in less moderate PA than women in moderate SEP neighborhoods (controlling for individual-level SEP) (Lee, Cubbin, & Winkleby, 2007) . Women in higher SEP neighborhoods engaged in more vigorous PA than the women in moderate SEP neighborhoods. The findings of this study suggest that women in lower SEP neighborhoods are engaged in PA that is part of their daily lifestyle, rather than in planned bouts of moderate or vigorous activity. This study did not find, as the studies described previously, that there was restricted access to PA resources in the lower SEP neighborhoods, and that the lower SEP neighborhoods with the greatest access to PA resources also had the highest levels of PA. These findings imply that PA resources may be particularly important to engagement in PA among residents of lower SEP neighborhoods (Lee et al., 2007).

In addition to a disparity in resources for PA, neighborhoods with lower SES are also more likely to have dangerous traffic conditions (Cubbin & Smith, 2002) and lower perceived safety from crime. A US study of 2,199 adults from 32 neighborhoods in Seattle, Washington and Baltimore, Maryland found residents of lower-income neighborhoods reported less favorable assessments of pedestrian/cycling facilities,

neighborhood aesthetics, access to recreation facilities, traffic safety, and crime safety than residents of high-income neighborhoods (Sallis et al., 2011).

Neighborhood Social Cohesion. Social cohesion is a theoretical construct that has been shown to influence health at the neighborhood level (Kawachi & Berkman, 2003). In a neighborhood with high social cohesion, individuals are more likely to act in ways that are favorable to the members of the group. Neighborhood social cohesion has been found to have a positive correlation to PA in both adults and children (Franzini et al., 2009; McNeill et al., 2006b). For instance, in a longitudinal study of 680 11-15 year-olds in Chicago followed over a 2-3 year period, social cohesion was positively associated with higher PA after controlling for individual- and neighborhood-level SES and overweight status (Cradock et al., 2009). Social contact and social exchange among members of a community may lead to the adoption of more-healthful behaviors and a culture favoring fitness (Cradock et al., 2009). Social cohesion affects PA in adult women as well, for example, women who frequently see other women exercising in their neighborhood engage in PA more often (King et al., 2000). The Wen, et al (2006) study of the California Health Interview Survey, mentioned previously, found social cohesion and access to parks were positively associated with higher levels of PA in terms of walking at recommended levels, after adjusting for individual-level sociodemographic factors, SEP and neighborhood-level SEP and safety.

Highly socially cohesive communities are more likely to have parent groups who know each other and who are willing to watch out for neighborhood children (collective socialization of children) (Franzini et al., 2009), which can also facilitate enforcement of

healthful norms, including support for PA. The level of social cohesion and collective socialization of children is also thought to influence parent's perceptions of safety pertaining to 'stranger danger,' the threat of abduction and/or abuse from a stranger (Carver et al., 2008).

Actual and Perceived Neighborhood Crime. Fear of crime is partially comprised of perceptions of neighborhood physical disorder (Scarborough, Like-Haislip, Novak, Lucas, & Alarid, 2010) and is inversely associated with social cohesion and collective efficacy (Sampson et al., 1997). Fear of crime has been shown to be inversely correlated with PA for both adults and children (Brownson, Baker, Housemann, Brennan, & Bacak, 2001), although this association is not consistent across all studies (Foster & Giles-Corti, 2008; Gordon-Larsen et al., 2006). This association is stronger among groups known to exhibit greater anxiety about crime, such as women, the elderly, members of deprived communities and those who have been victims or vicarious victims of crime (Foster & Giles-Corti, 2008). Kawachi and Berkman (2003) argue that subjective assessment of crime and fear of crime are stronger predictors of behaviors than objective rates. For instance, a study of overweight status among 7,020 low-income preschool children in Cincinnati, Ohio, which examined crime rates and 911 phone calls as independent variables, found no association between child overweight and crime rates (Burdette & Whitaker, 2004). This sample was fairly homogenous in terms of SEP (all families were low-income) and thus may not have had significant variation in crime rates to detect any differences.

Perceptions of crime may affect some populations differently. Studies indicate that parents (Carver et al., 2008) may estimate crime to be higher than crime data actually reflect and have higher perceptions of crime than their children. Parents may limit girls activities more than boys as a result of perceived or actual crime (Gómez et al., 2004).

Built Environment of Neighborhoods. The physical context of neighborhoods has been found to influence participation in PA for both mothers and children (Gordon-Larsen et al., 2006; Saelens, Sallis, Black, & Chen, 2003; Sallis et al., 2012; A. J. Schulz et al., 2005; van Jaarsveld et al., 2007). In particular, access to parks is correlated with PA in adults (Bedimo-Rung et al., 2005) and children (Sallis et al., 2012). Distance to travel to a park is considered to be a very strong indicator of PA in parks (Bedimo-Rung et al., 2005) as are numbers of parks and amount of parkland (Kaczynski, Potwarka, & Saelens, 2008) Estimates suggest most users of parks come from within less than one mile of the park. Perceived access to parks (Brownson et al., 2001), density of parks (Roux et al., 2007) and availability of multiple recreational activities in parks (Cohen et al., 2006; Floyd, Spengler, Maddock, Gobster, & Suau, 2008) are correlated with PA. Studies also show that the majority of park users engage in sedentary behavior while in the park, and that children are more likely than adults to expend energy in parks (Floyd et al., 2008).

It is important to note that access to parks does not affect PA equally among all groups; a review of studies of park settings for PA found that older adults, non-white ethnic groups, females and lower income families are less frequent users of parks for physical activity than other groups (Bedimo-Rung et al., 2005). These are also the

groups most likely to have lower levels of PA and higher rates of overweight and obesity (Centers for Disease Control, 2013; Centers for Disease Control and Prevention, 2014a).

Perceived Neighborhood Safety (PNS)

Introduction

The following literature review discusses the definition, development and importance of PNS, in order to lay a foundation for investigating how PNS impacts children's and mothers' engagement in PA. This section begins with a brief explanation of Social Disorganization Theory and the history of PNS research. Then studies studying the effects of PNS on PA are reviewed. The section concludes with a description of future directions for PNS research.

Historical Perspective and Definitions. According to the seminal review of the literature provided by Sampson, Morenoff & Gannon-Rowley (2002), social science research from the 1960's through the 1980's began to establish that an individual's perceptions of their neighborhood environment, particularly the safety of their neighborhood, were impacted by more than crime and demographic data. Other aspects of the neighborhood, including the physical environment and social organization and cohesiveness, are also important.

While there is no one standard definition of PNS, in the literature the term is often used interchangeably with "fear of crime." For the purposes of this dissertation, the definition of PNS is more inclusive. In a review of studies investigating the influence of parental PNS and children's PA, Carver, et al. (2008) found that there were three areas of 'fear' in the literature: fear of crime (e.g., property crime or physical harm), fear of

traffic, and "stranger danger," fear of abduction and/or abuse from an unknown individual. As the purpose of the dissertation is to determine how PNS impacts children's and mothers' PA, the definition of PNS must include the concepts that reflect fear of injury, which could be created by unsafe aspects of the built environment (e.g., rickety playground equipment, unsafe traffic situations) or the social environment (e.g., a neighborhood bar that routinely serves inebriated customers, creating a motor vehicle collision hazard). These inclusions are important to the research aims of this dissertation, as walking or riding bikes in the neighborhood for social interaction or transportation (e.g., to school or for transportation) is a common form of PA, and parents may impose limitations on these activities for reasons beyond fear of crime (Carver et al., 2008).

PNS contributes to overall perceptions of neighborhood quality, a distinct but closely-related concept. Neighborhood quality is a construct measuring resident's satisfaction with their neighbors and neighborhoods. It includes the concepts of neighborhood satisfaction, neighborhood problems, relationships with neighbors and neighborhood safety and has been independently linked to residents' well-being (Curtis, Dooley, & Phipps, 2004; Wen et al., 2006). For example, in a nationally representative study of children's well-being in Canada, parental report of better neighborhood quality was associated with higher levels of parent-rated child well-being after controlling for family characteristics, and neighborhoods rated as poor quality were associated with lower ratings of well-being for children (Curtis et al., 2004). A similar relationship between perceived neighborhood quality and self-rated adult well-being was found in a Cook County survey (Wen et al., 2006). This distinction is provided here as an

explanation of the important role PNS plays in developing an overall assessment of one's neighborhood quality.

Formation of PNS

Individuals' PNS are formed by a number of different factors, including individual-level characteristics, such as demographic characteristics and previous victimization, and neighborhood characteristics, including neighborhood demographics, social cohesion, perceptions of disorder, and the physical environment.

Individual characteristics. In terms of individual-level characteristics, studies have found that women are more fearful of crime than men (Austin et al., 2002), although men are more likely to experience victimization (Ferraro & LaGrange, 1992; Douglas D Perkins & Taylor, 2002). Additionally, fear of crime causes women to limit their activities more than men with similar levels of fear (Douglas D Perkins & Taylor, 2002). These findings are particularly germane to the present study, which focuses on mothers. SEP is usually inversely associated with fear of crime and positively associated with perceptions of safety (Austin et al., 2002; Baba & Austin, 1989).

Individual's previous experiences with criminal victimization have a negative relationship with perceptions of safety (Hicks & Brown, 2013), although this relationship varies based on the type of crime. For instance, victims of property victimization appear to have lower perceived safety than victims of personal victimization. Vicarious victimization – taking on the characteristics of a victim due to the victim experience of someone close to you – is also associated with reducing perceived safety, in much the same way as first-hand victim experience (Hicks & Brown, 2013)

Neighborhood characteristics. Social and physical aspects of neighborhoods play an important role in the formation of PNS (Austin et al., 2002). Neighborhoods with low SEP have physical and social characteristics that contribute to lower PNS (Sallis et al., 2011). Characteristics of the built environment, such as vacant buildings and other incivilities, are important influences on perceptions of safety (Sampson & Raudenbush, 2004). Studies have found that physical incivilities are directly related to increased crime and lower perceptions of safety (Pitner et al., 2012). This effect can be buffered by neighborhood social cohesion, which helps residents to exert social control and reduce criminal activity (Brown, Perkins, & Brown, 2004; Sampson et al., 2002). Collective efficacy, defined as the ability of residents working together to actively shape their communities (Sampson, Morenoff, & Felton, 1999), requires a high degree of social cohesion and studies have found these factors both contribute significantly to PNS (Ferreira et al., 2007; Franzini, Caughy, Spears, & Fernandez Esquer, 2005; Sampson & Raudenbush, 2004).

One study of particular interest to this research looked at both individual- and neighborhood-level contributions to PNS using structural equation modeling. In a study of Louisiana adults, Austin et al. (2002) examined the contributions of demographic effects, previous criminal victimization and the physical and social environments on PNS; this study did not explore the link to PA or restrict their sample to parents. However, it is useful in terms of understanding how adults form assessments of neighborhood safety. In this study, both standardized measures of the physical environment (via in-person assessments of housing quality) and residents' own subjective

perceptions were included, and some demographic factors (age, sex, homeownership and income) were included as exogenous (independent) variables, not as controls. This study also included previous victimization experiences and participants' satisfaction with the people in their neighborhood (the social environment) as exogenous variables. PNS was measured using four questions, including participant assessments on a four-item scale of whether people in the neighborhood: 1) need to lock their doors when gone for short periods, 2) have to worry about someone breaking in to their home to steal things, 3) can walk around at night without fear of being attacked or bothered, and 4) can leave property outside without fear of it being stolen. This conceptualization of safety is crime-oriented and is not necessarily focused on safety of the neighborhood for children; however, it does include aspects of property and personal crime fears.

The standardized assessment of housing quality had direct positive effects on perceived safety (Austin et al., 2002), as well as indirect affects through subjective assessments of the physical and social environments. Previous victimization was directly related to perceived safety and indirectly related to satisfaction with the physical environment, but was not related to satisfaction with the social environment. Sex, homeownership and income had direct relationships to perceived safety, and income was also an important influence on satisfaction with the social environment and accounted for much of housing quality's indirect and direct effects on perceptions of safety.

Studies of PNS and Mothers' Behaviors and Health Outcomes

Mothers' behaviors are affected by their perceptions of neighborhood safety in myriad ways (Bennett et al., 2007; Burdette & Whitaker, 2005; Carver et al., 2008; De

Jesus et al., 2010; Johnson et al., 2009; Miles, 2008; Molnar et al., 2004; Weir et al., 2006). Their own health-related behaviors as well as their parenting behaviors are affected, which may impact how their children behave and interact with their neighborhoods. A study of 412 residents from 50 blocks in Baltimore, Maryland found adults living in high crime neighborhoods tended to stay inside more often, have fewer social ties, higher levels of social isolation, and more fear and anxiety (Perkins & Taylor, 1996). Another Baltimore county study found that women who reported exposure to neighborhood violence were twice as likely to report poorer health, smoking, never exercising, and poorer sleep habits than those who had not been exposed (Johnson et al., 2009). In a study of 901 individuals in Washington, DC, women's fear of walking outside was positively associated with levels of violent crime and the number of gangs per block group (Roman & Chalfin, 2008).

Studies have demonstrated an inconsistent link between PNS and PA for adult women (Bennett et al., 2007; Brownson et al., 2001; Humpel, Owen, & Leslie, 2002). Sallis et al.(1997) hypothesized that this relationship is sometimes insignificant because adults who feel unsafe exercising in their neighborhoods will go elsewhere to engage in PA. Many of the same issues with measurement of PNS in children's PA also arise in studies focused on adult PA, and sometimes assessments of safety are muddied by inclusion in measures of overall neighborhood quality (Humpel et al., 2002).

Mothers' PNS also affects their parenting behaviors. A cross-sectional survey study of about 300 families found parents from inner city neighborhoods with lower SEP and higher rates of crime expressed significantly more stress and worry about play and

personal safety than suburban parents, which may lead to more restrictive parenting practices, such as limiting outdoor play (Weir et al., 2006). Studies have demonstrated that neighborhood conditions may affect parenting practices, as found in a longitudinal study of 348 families from 4 regions of the US (Pinderhughes, Nix, Foster, & Jones, 2001). In this study, parents who lived with their children in impoverished neighborhoods they perceived to be dangerous exhibited more harsh discipline and less warmth in interactions than parents who did not, even after adjusting for household SEP in the hierarchical regression analyses. These neighborhood effects on parenting outcomes were significant while parent race/ethnicity was not. As noted previously, another national study found that mothers with lower PNS allowed their children significantly higher television viewing time than mothers who perceived their neighborhoods as safe (Burdette & Whitaker, 2005).

Studies of PNS and Children's PA

Partially through effects on parent's stress and parenting behaviors and partially through children's own interactions with their neighborhoods, PNS and other neighborhood conditions affect children's mental and physical health (Leventhal & Brooks-Gunn, 2000); however, precisely how family and neighborhood variables act to affect these outcomes is unclear (Carver et al., 2008; Sampson et al., 2002). As children's PA is an important predictor of immediate and lifetime health (US Department of Health and Human Services, 2008; Wall et al., 2011), including health outcomes relating to healthy body weight and mental health (Centers for Disease Control, 2011), it is important that the public health and social services fields are able to understand and

intervene with individual- and neighborhood-level predictors of PA. To that end, the following sub-sections of this review examine research conceptualizing PNS in various ways: through fear of crime and/or disorder, through assessments of traffic safety and through more general assessments of perceived safety.

Studies conceptualizing PNS through fear of crime and/or disorder. In a study of 177 Hispanic adolescents in San Antonio, Texas, Gomez et al. (2004) measured both crime rates (within a .5 radius of the child's home) and perceptions of safety (agreement with "Not feeling safe in my neighborhood keeps me from exercising"). The study found that crime rates were inversely related to PA and perceived safety was positively related to bouts of PA, but only among girls in the study. In this study, crime rates were a stronger predictor of PA than perceived safety; however, the measurement of perceived safety included only safety from violent crime. A cross-sectional study in Cincinnati found no association between childhood obesity and neighborhood crime rates, but did not measure parental perceptions of safety (Burdette & Whitaker, 2004). In a Chicago study of 1,378 adolescents' PA (Molnar et al., 2004), subjective parental assessment of the neighborhood as unsafe for play and social disorder, assessed by videotapes of the social environment, were negatively associated with adolescent's PA. Physical disorder was also negatively associated with PA, but not significantly.

Another nationally representative study of children in 20 US cities found that mothers' PNS, measured by questions asking about observations of crime and crime-associated activities (e.g., drug dealing, loitering, gangs) was not significantly correlated with children's BMI or outdoor play time, but was correlated with increased TV viewing

time (Burdette & Whitaker, 2005). In this study, the questions measuring mothers' perceptions of safety were based on social disorder and did not cover all dimensions of safety that may impact children's PA (e.g., perceived safety of walking in the neighborhood, perceived traffic dangers).

In a multi-state study of fifth-graders and their caregivers, Franzini, et al. (2009) examined the influence of the social and physical environments on PA and obesity outcomes, based on the Social Determinants of Health and Environmental Health Promotion model, which describes how fundamental, intermediate, and proximate socioeconomic processes interact with the built environment to determine population health. Assessment of the social environment involved multiple scales measuring social cohesion, social control, collective efficacy, neighborhood exchange of favors, social ties, and PNS, which was measured with a single question about safety of walking alone in the neighborhood after dark. Measures of traffic, physical disorder, density and land use were conducted in-person to comprise the measures of the physical assessment. PA was measured through assessment of several factors (neighborhood play, organized activities). After controlling for sociodemographic factors, a favorable social environment was significantly positively associated with children's PA, which was significantly negatively associated with obesity. The physical environment was not associated with the measures of PA in this study; the authors speculate that this might have been because of the inclusion of organized activities, which are not necessarily dependent on the neighborhood physical environment. The measurement of parental PNS, while not directly related to play (and as assessed by only a single question), was a

strong indicator of a favorable social environment for children's PA, as were measures of collective efficacy, collective socialization of children and neighborhood exchange. This study did not examine whether the assessment of PNS was a mediator of the social environment variables, rather, PNS was considered an independent variable.

Studies conceptualizing PNS through traffic safety. Some studies have looked exclusively at perceptions of neighborhood traffic safety (also termed 'road safety'), but excluded fear of crime in the conceptualization of perceived safety. These studies have demonstrated that perceptions of traffic safety are positively correlated with increased walking and cycling activities (Carver et al., 2005; DeFrancesco, Bishai, Mahoney, Ho, & Guyer, 2004; Timperio, Crawford, Telford, & Salmon, 2004).

Studies measuring general or multifaceted PNS. In one of the only nationally representative longitudinal studies to examine the effects of PNS on children's PA and obesity, Datar et al. (2013) analyzed data from the Early Childhood Longitudinal Study data representing a kindergarten cohort of 19,000 children followed for 9 years (1998 to 2007). This study measured parental PNS with a single question: "How safe is it for children to play outside during the day in your neighborhood?" Parent changes in PNS were significantly related to changes in PA and sedentary behaviors, although effect sizes were small; changes in parents' PNS from "very safe" to "somewhat or not at all safe" were associated with 0.13 fewer days per week of vigorous physical activity and 0.40 additional hours per week of TV time. Changes in BMI and obesity were not significant. In this study, the researchers controlled for individual level covariates (age, race/ethnicity, household SES, urbanicity, family structure and size) and school-level

proxies for SES (including private school, % non-White children in school and school size). The researchers did not assess any measures of the neighborhood social or physical environments.

In another analysis of the Early Childhood Longitudinal Study, Beets & Foley (2008) did assess variables contributing to neighborhood quality, based primarily on Social Disorganization Theory, which included questions about crime, gangs, garbage and vacant buildings, as well as PNS, which was hypothesized to mediate the relationship between neighborhood quality and PA. As in Datar et al. (2013) PNS was measured using a single question asking parents to rate how safe their neighborhood is for children's outdoor play on a three-point scale. This study found that PNS fully mediated the relationship between neighborhood quality and children's PA. While quality influenced perceptions of safety, it was the perceptions of safety that directly influenced PA.

A smaller longitudinal study using data from the National Institute of Child Health and Human Development Study of Early Child Care and Youth Development (Lumeng, Appugliese, Cabral, Bradley, & Zuckerman, 2006), n=768 parents from 9 diverse US cities, measured parental PNS with a 5 question scale, covering aspects of overall neighborhood quality, satisfaction with police protection, crime and how well the police and members of the neighborhood get along. Parental perception of the neighborhood as less safe was independently associated with an increased risk of overweight at the age of 7 years, odds ratio 4.43 (CI 2.03-9.65). A study in New York (Weir et al., 2006) found that inner city parents (n=307 families from a family practice

medical office) were more concerned about neighborhood safety, especially traffic safety, than suburban parents, as measured by 7 questions covering both crime-related and traffic safety. They also found that neighborhood safety concerns were inversely related to their children's PA, measured by parental report of minutes per week engaged in PA.

Methodological Considerations

Studies of the link between neighborhood safety and PA have produced mixed results, perhaps because of variations in the measurement of safety and PA. Studies measuring perceptions of safety vary in terms of whether the measurement tools account for holistic definitions of safety (e.g., inclusive of traffic safety, play equipment safety, etc.) or focus specifically on crime, characteristics associated with disorder, or another singular aspect of safety. This often depends on whether the measure of PA is specific to a certain domain of PA, such as transportation activity, leisure-time activity, playground activity, etc. A review of 107 studies of relationships of neighborhood conditions, including PNS, to children's PA found that studies where PA was self-reported found more consistent relationships to neighborhood SEP, in part because the assessment of PA was more likely to be domain-specific. There is also an issue of whose perceptions of safety are measured: parents' or children's. For instance, Carver et al.'s (2008) review of the literature suggest that children are less concerned about traffic safety than parents, but parent's perceptions had stronger influence over children's PA and related behaviors.

In terms of perceptions of safety relating to crime, studies have used both actual crime rates, which may underestimate true levels of crime (as many crimes go unreported), and perceptions of safety or fear of crime (Carver et al., 2008). Kawachi

and Berkman (2003) argue that subjective assessment of crime and fear of crime are stronger predictors of behaviors than objective rates. Carver found in her review that parents perceive higher risks for crime than children and may overestimate crime risk compared to crime rates (Carver et al., 2008).

Definitions of PA vary as well; some studies use parental report of PA, measured in "bouts" of activity or estimated number of minutes per a given time period (usually a week) (Reilly et al., 2008). Other studies focus on certain forms of PA, such as walking or cycling in the neighborhood or counting instances of outdoor play in the neighborhood. Studies have also engaged with objective measures of PA, including data from accelerometers or pedometers, including more recent (2003 and later) iterations of the NHANES survey. In a comparison of NHANES measuring adherence to recommendations for PA using data collected by accelerometer and self-report data, self-reported estimates were much higher than those measured by accelerometer (Troiano et al., 2008). In a review of 148 studies using both objective and subjective measures, there was generally low correlation between the two (mean correlation of 0.37, SD=0.25) (Prince et al., 2008). Sixty percent of the studies in this review showed that self-report estimates were higher than the objectively measured values.

As Foster & Giles-Corti point out in their 2008 review, measurement of PA outcomes in many studies include physical activities that are not neighborhood specific. Additionally, walking-related PA behaviors demonstrate mixed results in terms of relationship to neighborhood SEP, in part because more people may be walking as transportation and/or to obtain public transportation. For instance, in the statewide-

representative California Health Interview Survey of over 41,500 adults, neighborhood SEP was not a correlate of walking, but social cohesion and access to a park were both significantly positively associated with walking at recommended levels (Wen, Kandula, & Lauderdale, 2007). In summary, studies examining relationships between neighborhood characteristics and individual engagement in PA should be evaluated in light of how neighborhood conditions and PA are measured, and whether the assessment of the neighborhood includes variables that are relevant to the type of PA under study, as well as the measure of PA being used.

Chapter Summary and Conclusion

In summary, physical activity (PA) is an essential component of a healthy lifestyle and adequate levels of engagement in PA are required to prevent overweight and obesity (Centers for Disease Control, 2011). Correlates of PA for mothers and children are present across social-ecological domains (Bauman et al., 2012; Sallis et al., 2012). Individual-level factors, such as demographic characteristics (e.g., gender, health, and genetics), familial influence and structure (e.g. family support of PA), psychosocial characteristics (e.g. mental health status, social support) and household socioeconomic position are important predictors of PA. Additionally, neighborhood-level factors have important influence on PA, independent of individual-level characteristics (Braveman et al., 2005; Saelens et al., 2012; Sallis et al., 2012).

Perceptions of neighborhood safety (PNS) may mediate relationships between individual and neighborhood factors and PA (Beets & Foley, 2008; Lumeng et al., 2006; Weir et al., 2006). Social Disorganization Theory (Franzini et al., 2008; Sampson &

Groves, 1989) involves the interplay of social cohesion, collective efficacy and physical environments to prevent crime and promote desired behaviors in neighborhoods. This research posits that investigation of a comprehensive definition of PNS that includes social cohesion, safety from crime, general perceptions of safety and traffic safety is warranted. The literature reviewed in this section provided evidence for the theoretical linkages explored in this study's three research aims:

(Aim 1) To determine if a multi-factorial conceptualization of maternal PNS – as opposed to the singular approaches predominate in the literature - is supported by the GROW study data,

(Aim 2) To examine the potential mediating role of PNS in the pathways between neighborhood and household socioeconomic conditions, park availability/safety and children's PA, followed by an examination of the role of child gender as a potential moderator of these relationships, and

(Aim 3) To examine the potential mediating roles of PNS and social cohesion in the pathways between neighborhood and household socioeconomic conditions, park availability/safety and mothers' PA.

Chapter 3: Examination of a Multivariate Conceptualization of Mothers' Perceived Neighborhood Safety (Aim 1)

Introduction

Perceptions of neighborhood safety (PNS) impact women's perceptions of neighborhood quality (Curtis et al., 2004; Wen et al., 2006), parenting behaviors (Kling, Liebman, & Katz, 2007; Pinderhughes et al., 2001; Weir et al., 2006) and their children's participation in neighborhood-based physical activity (PA) (Brownson et al., 2001; Carver et al., 2008). PNS may also affect women's PA, although this link has been inconsistent in previous research studies (Foster & Giles-Corti, 2008; Gordon-Larsen et al., 2006). However, stronger social cohesion, which is often studied as a component of PNS, does appear to positively impact women's participation in PA (McNeill et al., 2006b; Wen et al., 2007). Mechanisms by which social cohesion may act on women's PA include reduced neighborhood crime (Ross & Jang, 2000), increased trust among neighbors (Kawachi & Berkman, 2000; Kawachi & Berkman, 2003) and increased social support (Eyler et al., 2002; Sternfeld et al., 1999).

Several previous studies examining the effects of PNS on PA have conceptualized PNS through a single dimension measuring fear of crime. In some, fear of crime has been examined as direct or vicarious experiences with crime (Hicks & Brown, 2013). Others have used perceptions of crime (Kawachi & Berkman, 2003). Perceptions of crime appear to negatively impact physical activity and related behaviors more than actual crime rates, which tend to underestimate actual crime (Kawachi & Berkman, 2003; Kawachi, Kennedy, & Wilkinson, 1999). Perceptions of traffic safety have also shown

positive associations with children's PA when it is conceptualized as walking or cycling in the neighborhood, in a number of studies (Carver et al., 2005; Carver et al., 2010; DeFrancesco et al., 2004; Timperio et al., 2004). Studies have also found associations with PA using single questions measuring PNS. These questions may focus on general PNS (Franzini et al., 2009) or on PNS specifically for children's play in the neighborhood (Beets & Foley, 2008). Others have used multiple questions to assess several aspects of PNS (Lumeng et al., 2006; Weir et al., 2006).

No studies to date have incorporated all of these aspects of PNS (safety from crime, general safety, social cohesion, safety for play and traffic safety) to assess how PNS affects children's or mothers' PA. The GROW study includes items addressing each of these aspects, and therefore provides an opportunity to study whether a comprehensive assessment of neighborhood safety may impact children's and mothers' PA. To that end, the first aim of this research study is to conduct a confirmatory factor analysis (CFA) to assess a multidimensional measure of PNS made up of four hypothesized latent factors: perceptions of general safety, safety for play (including traffic safety), safety from crime and social cohesion, using data collected in the GROW survey. This chapter begins with a brief overview of SEM and CFA key terms and procedures. The methods and results for the first- and second-order factor analyses are then presented, followed by a discussion of the results as they relate to the subsequent research aims of this dissertation.

Description of Key Terms in SEM and CFA

There are a number of key terms used in SEM that require definition to better understand the analyses presented in this chapter. This section provides a description of those key terms, an overview of first and second-order factor analysis and a discussion of the model fit statistics used in this dissertation.

Indicators and Factors. In SEM, observed variables are known as *indicators* and are depicted in SEM diagrams as a rectangle or square (Geiser, 2012). Latent variables, which are unobserved, are termed *factors* and are regressed onto the indicator variables. Factors are depicted as ovals or circles in SEM diagrams. Directional relationships (*paths*) between factors and/or indicators are shown with straight-lines and arrows, while non-directional *covariances* are depicted with double-headed arrows.

Endogenous and Exogenous Factors. SEM uses the terminology exogenous and endogenous to describe the actions of factors and indicators (Geiser, 2012). Exogenous factors or indicators receive no causal inputs, but may covary with other indicators or factors. Exogenous factors are most similar to independent variables in other applications. Endogenous factors or indicators receive one or more causal inputs and are most similar to dependent variables.

First and Second-order Factor Analysis. The purpose of the factor analysis process is to determine the factorial validity of a theoretical construct for perceived neighborhood safety (PNS). In the factor structure proposed for this analysis, the factors General Safety, Play Safety, Crime-related Safety and Social Cohesion are comprised of

indicators from the GROW survey as described in Table 3.1 and are hypothesized to work together to form a latent factor for PNS.

In first-order factor analysis, only non-directional relationships are assumed between the factors (Geiser, 2012) and they are all expected to covary (Kline, 2011). The first-order factor analysis process is undertaken to determine if this factor structure fits the data well; if so, it would be reasonable that these latent factors could be estimated by a single latent factor, PNS. An estimate of how well the single latent factor PNS estimates the factors from the first-order analysis is provided by the second-order factor analysis. This CFA process will inform part of the measurement model for the full SEM in Aim 2.

Description of Fit Statistics. SEM uses a series of fit statistics to determine how well a model fits the data compared to a baseline model in which all parameters in the model are assumed to be exogenous and unrelated. The fit statistics used in this research study, which contains categorical and continuous indicators, are as follows.

Normed chi-square statistic (χ^2/degrees of freedom). In SEM the χ^2 statistic is one way to assess fit (Kline, 2011). Ideally, a very nearly perfect model would have a non-significant χ^2 statistic, which would state that the covariance matrices observed in the data and the covariance matrices implied for the population are not significantly different. This can be difficult to achieve, especially with a large sample and/or if the data are not normally distributed. The normed χ^2 statistic is calculated by dividing the χ^2 by the degrees of freedom in the model, which takes into account how many parameters are estimated. A normed χ^2 of less than 5 is generally considered acceptable.

Root mean squares error of approximation (RMSEA). The RMSEA is a useful tool for assessing closeness of fit of the hypothesized model to the data. Unlike the CFI and TLI described below, RMSEA is an absolute fit statistic and a measure of the "poorness" of fit, therefore is not comparing the hypothesized model to a baseline model. A RMSEA of .05 or lower is generally considered acceptable. The matrix utilizing the 90% CI of the RMSEA as specified by MacCallum, Browne & Sugawara (1996) is helpful in decision making around the acceptability of the fit of a hypothesized model:

If the 90% CI is:	reject close fit	reject not close fit
below .05	no	yes
straddles .05	no	no
above .05	yes	no

Bentler Comparitive Fit Index (CFI). The CFI is an index measuring the relative improvement in fit of the hypothesized model over that of a baseline model where all covariances are assumed to be zero (Kline, 2011). The CFI ranges from 0.0 to 1.0. When originally developed a score of .90 or higher was considered acceptable (Hu & Bentler, 1999), but currently the majority of SEM researchers use the Hu & Bentler criteria for acceptable CFI, which requires a score of $\geq .95$. This criteria is often used in combination with the Standardized Root Mean Square Residual (SRMR) which is not available for this research study as it is only calculated when continuous variables comprise the SEM.

Tucker Lewis Index (TLI). Also termed the Bentler-Bonett Non-normed Fit Index, the TLI is another incremental fit index (Kline, 2011). It uses ratios of the χ^2/df for the hypothesized and baseline models to calculate a fit index that goes from 0.0 to 1 (although the TLI can go above 1, it usually does not). As the TLI adjusts for the degrees of freedom in the model, it takes parsimony into account and prefers simpler models and penalizes models with more parameters to be estimated. Like CFI, a TLI of .90 was once considered acceptable, and current preference is for a score of .95 or higher (Hu & Bentler, 1999).

First-Order Factor Analysis

The comprehensive conceptualization of PNS examined in this analysis involves four domains: general safety, play safety, crime-related safety and social cohesion. Descriptive analyses of the indicators and latent factors used in this analysis are described in Table 3.1. A diagram of the first order factor analyses model as hypothesized *a priori* is provided in Figure 3.

Table 3.1 Proposed dimensions of PNS with corresponding indicators from GROW

Dimension of PNS	Variable name	Items from GROW contributing to each dimension (variable name)	Frequency	Weighted %
General Safety *(gsafe)*	*safe*	The main reason I selected this neighborhood was because it felt safe.	Yes = 2226	80.6
	nsafe	I feel comfortable walking in my neighborhood at night.		
		Strongly agree	618	20.1
		Agree	1344	50.0
		Disagree	544	20.7
		Strongly disagree	173	6.3
		Missing	71	2.9
Play Safety *(psasfe)*	*nunsuperv*	I often see children in my neighborhood play outside without adult supervision.		
		Strongly agree	403	13.7
		Agree	980	35.6
		Disagree	1037	38.5
		Strongly disagree	285	10.4
		Missing	45	1.9
	ntraffic	Traffic is dangerous for children in my neighborhood.		
		Strongly agree	236	8.4
		Agree	901	33.1
		Disagree	1229	45.2
		Strongly disagree	338	11.5
		Missing	46	1.7

Table 3.1 continued				
Safety from Crime *(crime)*	*nstolen*	Since you started living in this neighborhood, have you or anyone in your home had anything stolen inside your home?	Yes = 312 (0.5% missing)	11.8
	nviolence	Since you started living in this neighborhood, have you or anyone in your household ever seen or been a victim of violence in your neighborhood (such as purse snatching, mugging, fight, or sexual assault)?	Yes = 324 (0.6% missing)	12.1
	ncrime	How safe is your neighborhood from crime?		
		Very safe	956	32.8
		Somewhat safe	1362	50.8
		Somewhat unsafe	343	13.1
		Very unsafe	64	2.2
		Missing	25	1.0
Social Cohesion Index *(cohesion)*			Mean	Missing %
	nfeelhome[1]	Feel at home in neighborhood	3.31	1.2
	nconnect[1]	Neighbors feel connected	2.90	3.7
	nhelp[1]	People in neighborhood are willing to help others	3.02	4.3
	ngetalong[1]	People in neighborhood get along	3.12	2.7
	nvalues[1]	People in neighborhood share values	2.84	8.7
	ntrust[1]	People in neighborhood can be trusted	2.91	6.4

[1] measured on a 1-4 scale, strongly agree (4) to strongly disagree (1)

Methods

This first-order factor analysis consists of latent variables: General Safety, Play Safety, Safety from Crime (termed 'Crime' in the Figures) and Social Cohesion. The first-order factor analysis of the four-factor structure (Figure 3.1) was conducted in

Mplus using a TYPE=Complex analysis to account for the stratified sample design. Missing data was handled using full-information maximum likelihood estimation (FIML). Mplus uses a robust weighted least squares (WLSMV) estimator when there are both categorical and continuous indicators (Muthén & Muthén, 2012). The WLSMV estimates probit regressions for the categorical factor indicators, and linear regressions for the continuous factor indicators. A number of variables were reverse coded in Mplus so that all factor loadings would be in the same direction and larger values would indicate higher levels of perceived safety. These reverse-coded variables included *safe, nsafe, ncrime* and all of the social cohesion indicators. Modifications to the model as indicated by the results were performed as necessary and the results of each iteration were recorded and are presented in the results.

Results

Four-factor Structure. The four-factor structure had good model fit but was not considered positive definite because the latent factors General Safety and Play Safety demonstrated an estimated correlation > 1 (1.215). This is considered an "inadmissible parameter estimate" (Geiser, 2012, p. 61) and indicates that the model may be mis-specified and/or have two few indicators per factor. As these two factors were too highly correlated to remain in the model together, and the latent variable General Safety only had two indicators, they were combined into a single factor, termed "General Safety" for the subsequent analyses.

Three-factor Structure.

Iteration One. The resulting three-factor model with General Safety, Safety from Crime and Social Cohesion was tested and had a good fit to the data. The model has 42 free parameters, and a sample size of 2,749. This exceeds the generally accepted requirement of 10 participants per parameter to be estimated with 65.42 participants/parameter (Schreiber, Nora, Stage, Barlow, & King, 2006). The model appears to be a good fit to the data; the comparative fit index (CFI) is .925 and the Tucker-Lewis index is .907. As expected with a sample size of more than 200, the chi-square statistic is significant, 706.60 (74), $p<.01$. Ideally the CFI and/or TLI would approach .95 or higher (Schreiber et al., 2006). The RMSEA of .056 (90% CI: .052, .060) is within the ideal range of <.06 to .08.

Within this factor structure the indicator *nunsuperv* was hypothesized to load onto the latent variable Play Safety. *Nunsuperv* is an indicator reflecting agreement with the statement "I often see children in my neighborhood play outside without adult supervision," measured on a 4-point Likert scale. *Nunsuperv* had a standardized factor loading onto the latent variable Play Safety of only .058 This is substantially lower than all other factor loadings in the model, which were all .4 or higher. This very low loading indicates that the indicator is not contributing substantially to the latent construct. Originally, agreement with this statement was hypothesized to indicate a safer neighborhood. Upon further consideration based on the poor loading, it became clear that the hypothesized interpretation of this indicator was inaccurate. Agreement with this statement might not be at all related to safety, or could even indicate a less safe

neighborhood for children. This variable was therefore removed from the model going forward.

Iteration 2. The three-factor structure with *nunsuperv* removed from the model was analyzed and had a slightly worsened model fit (see Table 3.2). CFI and TLI decreased slightly and RMSEA increased slightly. The χ^2 statistic for the model also increased. Modification indices in the Mplus output suggested adding covariance paths between 7 error terms in the social cohesion factor: 1) *nhelp* with *nfeelhome*, (2) *nhelp* with *nconnect*, (2) *ngetalong* with *nfeelhome*, (4) *ngetalong* with *nconnect*, (5) *ngetalong* with *nhelp* (6) *nvalues* with *nfeelhome*, (7) *nvalues* with *nconnect* one between the error terms for the two variables measuring experiences of crime (*nstolen* and *nviolence*). Adding these error covariance paths makes theoretical sense as they are all within the same theoretical construct and are highly related.

Iteration 3. With the 8 error term covariance paths in the social cohesion factor, the model fit was improved (see Iteration 3, Table 3.2). RMSEA was further lowered to .044 (.040, .049), CFI improved to .965, TLI improved to .948 and χ^2 was lowered. The results of these analyses by iteration are summarized in Table 3.2 and the factor loadings are provided in Table 3.3.

Figure 3.1 Hypothesized first-order factor structure for PNS

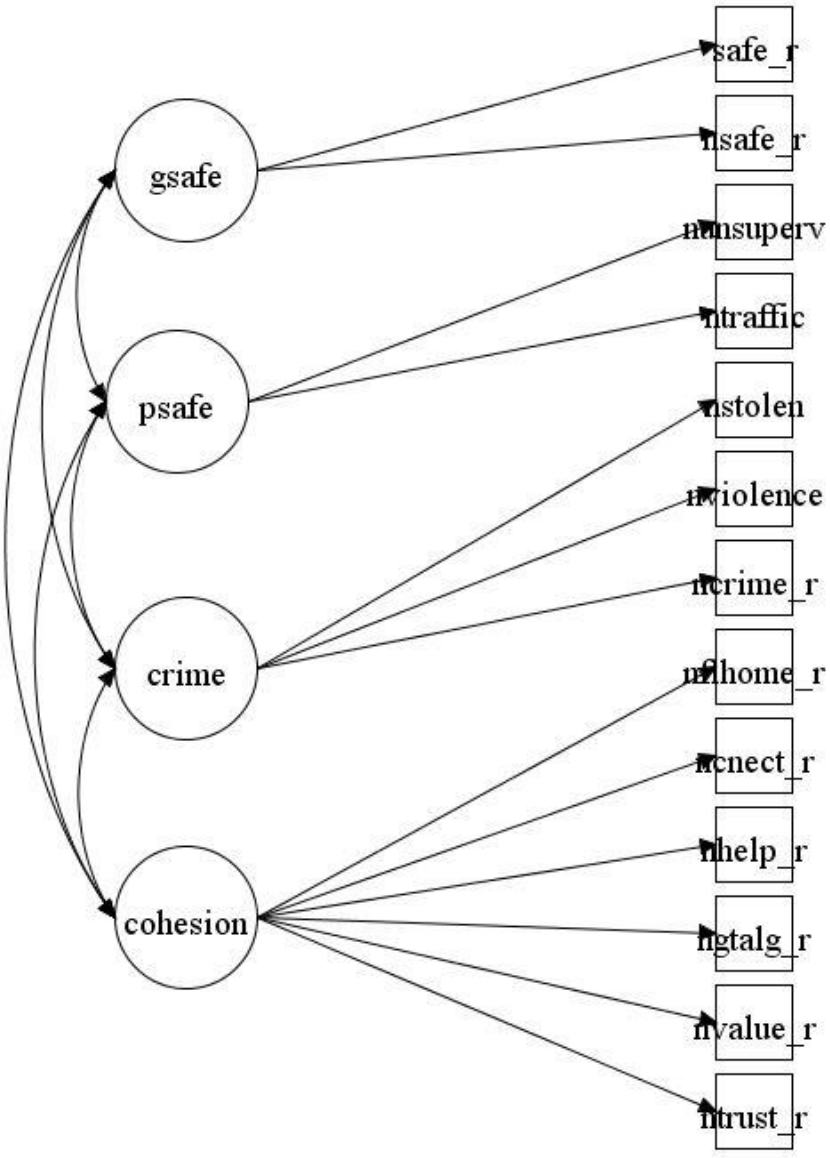


Figure 3.2 Final modified first-order factor analysis, showing standardized factor loadings, all paths significant (p< .001)

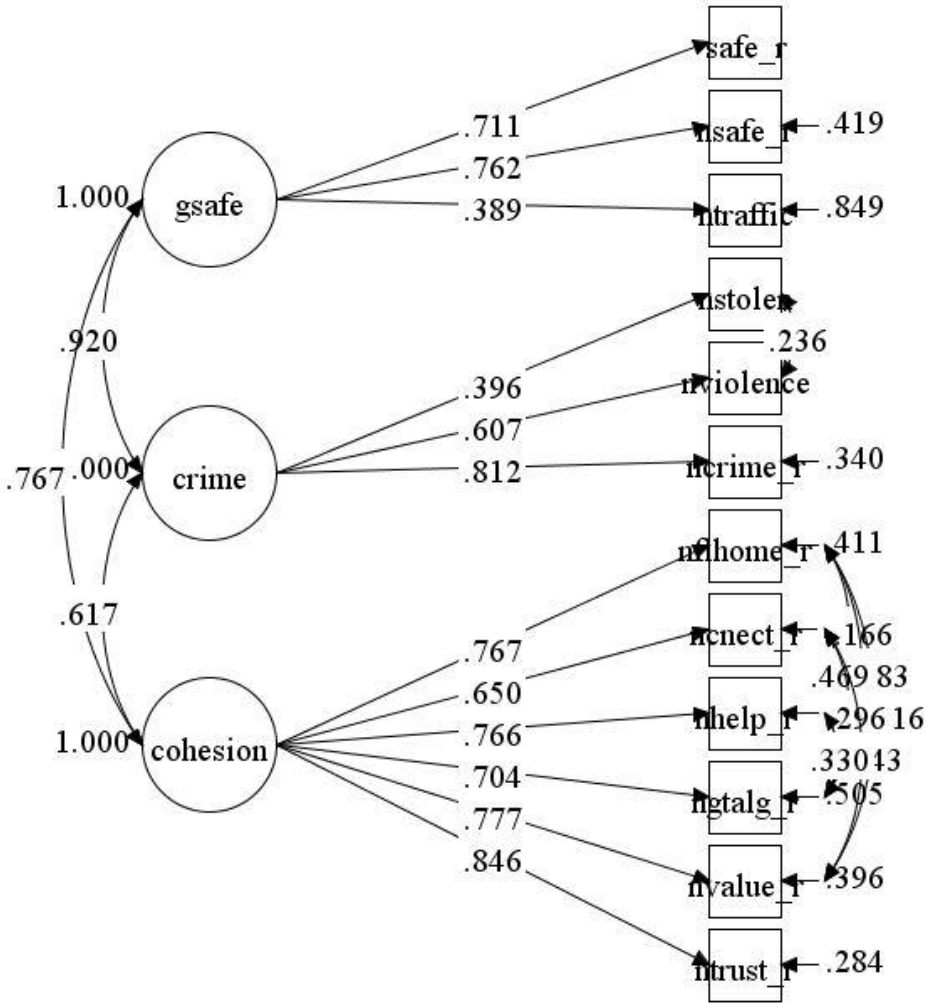


Table 3.2 Fit indices for iterations of first-order factor analysis of three-factor model

Fit Statistic	Iteration 1	Iteration 2	Iteration 3
	3 factor structure	delete *nunsuperv*	with 8 error covariance paths
χ^2 (df)	541.12 (62)	544.94 (51)	239.31 (43)
χ^2/df	8.72	10.68	5.56
CFI	.937	.931	.973
TLI	.920	.911	.958
RMSEA	.053	.059	.041
(90% CI)	(.049, .057)	(.055, .064)	(.036, .046)

*=significant at p<.001

Table 3.3. Standardized (β) and unstandardized (B) factor loadings for final first-order factor structure.

	β	B	S.E	P-Value
General Safety by				
safe	0.711	1.000[1]	0.000	na
nsafe	0.762	0.873	0.040	<.001
ntraffic	0.389	0.440	0.029	<.001
Safety from Crime by				
nstolen	0.396	1.000[1]	0.000	na
nviolence	0.607	1.531	0.163	<.001
ncrime	0.812	1.493	0.156	<.001
Social Cohesion by				
nfeelhome	0.767	1.000[1]	0.000	na
nconnect	0.650	0.907	0.035	<.001
nhelp	0.766	1.015	0.031	<.001
ngetalong	0.704	0.781	0.026	<.001
nvalue	0.777	1.014	0.033	<.001
ntrust	0.846	1.120	0.035	<.001

[1] SEM analyses require one variable loading on each latent factor to be set equal to 1.00 to set the metric for that factor. As a result, significance values are not calculated for these variable loadings.

Second-Order Factor Analysis

Methods

The second-order factor analysis involves removing the covariance paths between the latent factors and regressing the hypothesized latent factor PNS on each of the latent factors. This process determines if the latent factors can be represented by one unifying factor, in this case PNS.

Results

Iteration one. In the first test of the second-order factor structure, the latent variable covariance matrix is not positive definite due to a negative residual variance for the General Safety latent variable. As the negative residual variance is small and non-significant, the model can be modified by constraining the General Safety latent variable residual variance to zero.

Iteration two. With the residual variance of the General Safety factor set to 0 the second-order factor structure has an excellent fit to the data, with CFI an TLI at or above .95 and RMSEA = .042 (Table 3.4). All paths are significant and all the standardized factor loadings are above 0.73 (Figure 3.4, Table 3.5). However, it is important to note that the second-order portion of the factor structure is just-identified, meaning that the number of observations to be estimated are equal to the number of free parameters (Kline, 2011). A just-identified structure cannot provide much useful information, and in this case, the model performance is very similar to the final first-order structure.

Table 3.4. Fit Statistics of second-order factor analysis of PNS

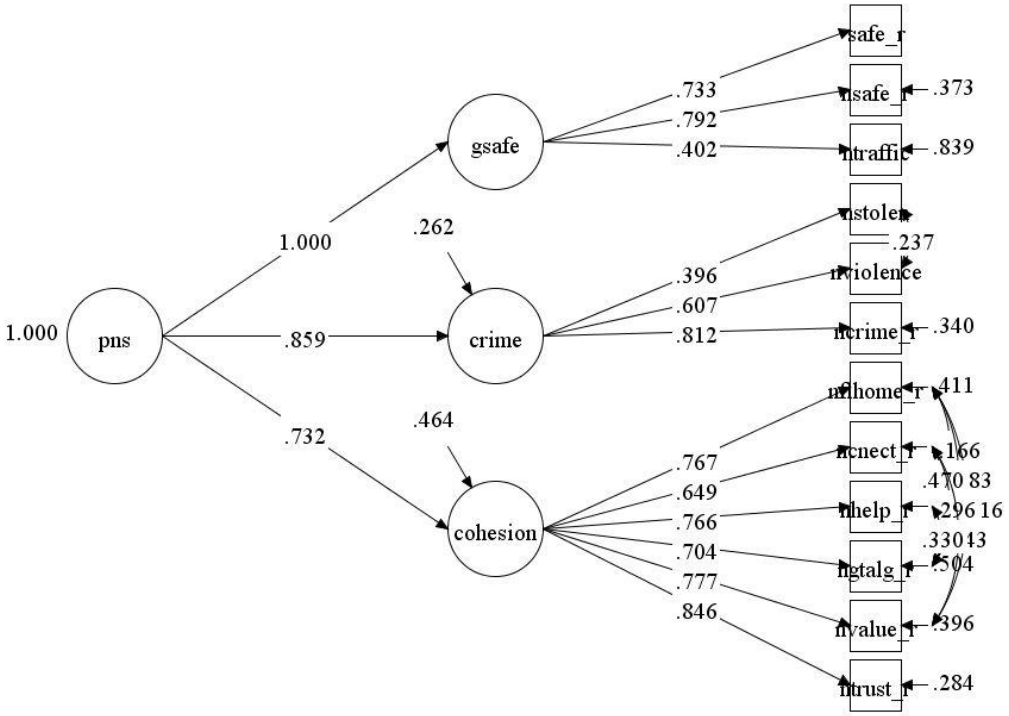
	Iteration 1	Iteration 2 With General Safety @0
χ^2 (df)	Model is not positive definite due to negative residual variance of General Safety factor	252.51 (44)*
χ^2/df		5.73
RMSEA		.042
(90% CI)		(.037, .047)
CFI		.971
TLI		.956

*=significant at p<.001

Table 3.5. Standardized (β) and unstandardized (B) second-order factor loadings for second-order PNS factor structure

	β	B	S.E	P-Value
PNS by				
General Safety		*n.a. – set to 0*		
Safety from Crime	.859	.465	.051	<.001
Social Cohesion	.732	.523	.024	<.001

Figure 3.3 Second-order factor structure, showing standardized factor loadings, all paths significant



Summary of Aim 1 Findings

The final model for PNS contains three latent factors: General Safety, Safety from Crime and Social Cohesion. This second-order CFA model has a good fit to the data and all of the paths are significant, with all factor loadings above .35 in the expected directions.

First-order factor analysis. The first-order factor analysis indicated that the indicator *nunsuperv* did not contribute meaningfully to the hypothesized latent factor for

Play Safety (Iteration 1). Therefore *nunsuperv* was deleted from the subsequent analyses (Iteration 2). With *nunsuperv* removed from the model, the latent factor General Safety had two indicators, and was correlated >1 with the latent factor Play Safety. Therefore, the two factors were combined into a General Safety factor (Iteration 2). The resulting three factor structure, inclusive of 8 error term covariance paths and consisting of General Safety, Safety from Crime and Social Cohesion, achieved an acceptable fit to the data (Iteration 3).

Second-order factor analysis. The second-order factor analysis demonstrated that a latent factor for mothers' PNS can be estimated from the three factor structure. However the second-order structure is just-identified, so it does not add a substantial amount of information. The second-order structure fits the data in a manner very similar to the first-order structure, as would be expected for a just-identified structure.

Conclusions

The creation of a second-order factor for PNS from a multi-factor structure composed of items from the GROW study representing areas of general safety, safety from crime, and social cohesion was supported. This comprehensive assessment of PNS will therefore be used to assess the impact of mothers' PNS on their own and their children's PA in the subsequent aims of this research study. This research may add to the understanding of how PNS can impact PA and may also have implications for how future studies conceptualize PNS for research on other health outcomes.

Chapter 4: Analysis of Individual and Neighborhood-level Influences on Children's and Mothers' Physical Activity (Aims 2 and 3)

Overview

Background

As discussed in previous chapters, physical activity (PA) is an essential component of health known to prevent overweight and obesity in children and adults (Centers for Disease Control, 2011). Systematic reviews of correlates to PA repeatedly confirm the influence of factors from multiple ecological levels, including individual and neighborhood levels, on PA (Hinkley et al., 2008; Sallis et al., 2012; Sallis et al., 2000). Additionally, perceptions of neighborhood safety (PNS) have been shown to influence children's PA (Carver et al., 2008) and are less consistently related to mothers' PA (Foster & Giles-Corti, 2008). This chapter begins with an overview of the study purpose and format, followed by a brief review describing evidence supporting the correlates to PA included in the study.

Purpose

The purpose of this chapter was to address Aim 1 of this dissertation by examining the role of a comprehensive assessment of mothers' perceptions of neighborhood safety (PNS) as a mediator of known relationships between social and environmental correlates of children's and mothers' PA (Carver et al., 2008; Ferreira et al., 2007; Franzini et al., 2009; Giles-Corti & Donovan, 2002a; Hinkley et al., 2008; L. H. McNeill, M. W. Kreuter, & S. Subramanian, 2006a; Sallis et al., 2012; Sallis & Glanz, 2006; Sallis et al., 2000; Trost et al., 2002; Van der Horst et al., 2007).

Household Socioeconomic Position (SEP). The concept of individual- or household-level (SEP) can encompass several facets of economic and social standing, including income, education, homeownership, wealth and other indicators (Braveman et al., 2005). Ten years of data from the National Health and Nutrition Examination Survey (NHANES) (1999-2008) reveal that children ages 6-17 from low-income households have a higher prevalence of obesity and sedentary behavior, defined as reporting no PA within the month preceding the survey, than their peers from higher income households (Ali et al., 2011). Other studies of NHANES data have demonstrated positive associations with educational attainment and self-reported PA among adults (Dowda et al., 2003). In studies of adult women, educational attainment is consistently positively related to PA, as found in the review of 91 studies of women by Eyler, et al. (2002).

Neighborhood SEP. Indicators of neighborhood-level SEP may include median family income, poverty rates, employment status, percentages of college graduates and rates of homeownership, among other factors (Braveman et al., 2005). Neighborhood SEP is positively associated with PA in population-based studies of adults (Stimpson et al., 2007) and children (Gordon-Larsen et al., 2006; Greves Grow et al., 2010; Singh et al., 2008), although not all studies have found this relationship to hold after controlling for individual-level factors, including individual-level SEP (Lee & Cubbin, 2002). Differences in PA across neighborhoods with varying levels of SEP may be due in part to disparities in access to recreational outlets (Gordon-Larsen et al., 2006; Powell et al., 2006) and other environmental characteristics, such as pedestrian/cycling facilities and traffic (Giles-Corti & Donovan, 2002b; Sallis et al., 2011).

Parks. Access to safe and useable parks and other recreational amenities are important factors in PA attainment among adults and children (Bauman et al., 2012; Giles-Corti & Donovan, 2002b; Gordon-Larsen et al., 2006; Powell et al., 2006; Saelens et al., 2012; Sallis et al., 2011; A. Schulz & Northridge, 2004).

Perceived Neighborhood Safety (PNS). As discussed previously, PNS has been defined in myriad ways throughout the literature. Parental PNS is fairly consistently positively associated with children's PA (Beets & Foley, 2008; Carver et al., 2005; Carver et al., 2008; DeFrancesco et al., 2004; Gómez et al., 2004; Lumeng et al., 2006; Molnar et al., 2004; Timperio et al., 2004; Weir et al., 2006). PNS is less consistently associated with adults' PA (Bennett et al., 2007; Brownson et al., 2001; Foster & Giles-Corti, 2008; Humpel et al., 2002). However, other social aspects of the neighborhood that are related to PNS, including social cohesion and other measures of the neighborhood social environment, do appear to be positively related to adult women's PA attainment (Franzini et al., 2009; King et al., 2000; McNeill et al., 2006a; Wen et al., 2006).

Methods Overview

Exogenous (independent) latent factors examined as predictors of PA in the models include household- and neighborhood-level socioeconomic position (SEP) and subjective assessment of the availability and safety of neighborhood parks. The measure of PNS arrived at through the confirmatory factor analysis described in Chapter 3 is hypothesized to mediate these relationships. The factor structure is first examined through a measurement model. The measurement model provides the foundation for full

structural models exploring plausibly causal pathways between factors for both children's and mothers' PA outcomes. The children's PA model is presented first, followed by a test for gender invariance. The mothers' PA model is then presented. These are followed by exploratory models examining social cohesion as a mediator for both children's and mother's PA. The chapter concludes with a brief summary of the results.

Indicator Measurement

Household Socioeconomic Position (HSEP). The latent factor for household SEP is measured using 4 indicators. Household income as a percentage of the Federal Poverty Level, was self-reported in 10,000 dollar increments on the GROW survey, and was then categorized as 0-100%, 101-200%, 201-300% or >400% of the federal poverty level. Mother's education was conceptualized by academic milestones in 6 categories. Food security was assessed using responses to 6 questions about women's ability to purchase food and provide meals for themselves and their families in relation to monetary resources. Homeownership was dichotomous and referred to whether or not the respondent is a homeowner. All indicators were coded so that higher values would indicate higher household SEP.

Neighborhood SEP. The five indicators of neighborhood SEP were calculated from the American Community Survey 2005-2009 (ACS), an ongoing annual survey conducted by the US Census that collects data similar to that obtained in the decennial census. Census tract-level variables were linked to the GROW database via census geocodes at the time of birth, at the time of MIHA, and at the time of GROW. Indicators included in this analysis include: median family income, median housing value, the

percentage of adults over age 25 who have graduated from college, the percentage of unemployed adults over age 16 who are in the civilian workforce, and the percentage of adults in the blue collar workforce (i.e., those who work in construction or production jobs). All indicators were coded so that higher values would indicate higher neighborhood SEP.

Park Availability and Safety. The indicators contributing to this latent factor include respondent's assessments of whether there are good parks or playgrounds in the neighborhood and how comfortable she is visiting these parks in the daytime. Both indicators are coded on a 4-point scale and higher levels indicate higher ratings of availability and safety.

Descriptive Statistics and Bivariate Analyses

Analyses describing the sample through means and frequency distributions were conducted in SPSS and are provided in Table 4.1. Bivariate analyses for all exogenous factors and covariates are were also conducted in SPSS. One-way ANOVAs were used to compare mean scores on the children's and mother's PA model by the categorical exogenous factors (Table 4.2). Pearson's R correlations were used to examine correlations between continuous variables (Table 4.3). Bivariate analyses providing correlations between the latent factors in the model calculated using Mplus are provided in Table 4.4.

Structural Equation Modeling (SEM)

SEM is used in this study to test a theoretical framework examining how three exogenous latent factors, household socioeconomic position (HSEP), neighborhood

socioeconomic position (NSEP) and availability/safety of parks (Parks), mediated by mothers' perceptions of neighborhood safety (PNS), effect children's PA (*cphsyact*) and mothers' PA (*mphsyact*). Mplus v.7 is used for all the SEM analyses in this study because of its ability to analyze weighted data from a stratified sample, using its TYPE=COMPLEX function.

Structural equation models consist of two components: a measurement model and a structural model. The measurement model consists of the indicators and latent factors that are used in the hypothesized model and is used to assess the extent of relationships and covariation among the latent constructs, in a manner very similar to confirmatory factor analysis. The factor loadings, variances and modification indices produced by the measurement model can be useful in that they inform the researcher about possible modifications that can create a better fitting set of latent indicators prior to progressing to assessment of the structural path model (Schreiber et al., 2006).

In the structural model, the hypothesized relationships between latent constructs and indicators are tested in a series of structural equations (Kline, 2005). Direct relationships between *exogenous* (independent) indicators or factors and *endogenous* (dependent) variables are referred to as *direct effects. Indirect effect* refers to the effect of an independent variable on the dependent variable through a mediating variable. Direct and indirect effects of exogenous variables on endogenous variables are represented by a series of arrows that specify the direction of the relationship. Variables in an SEM model can be considered endogenous and exogenous simultaneously.

Estimation Procedure and Goodness of Fit. Mplus utilizes a weighted least squares estimator referred to as WLSMV when there are both categorical and continuous indicators in the model (Muthén & Muthén, 2012). This estimator produces a number of goodness of fit indices, including χ^2 test of model fit, root mean square error of approximation (RMSEA), the comparative fit index (CFI), the Tucker-Lewis Index (TLI), and the weighted root mean square residual (WRMR).

Missing data. In the current sample, there is a small percentage of missing data (≤10% on all variables). Table 4.1 shows percentage of missing data for each variable in the study. Mplus accounts for missing data using a full information procedure (FIML). FIML allows for SEM to take place without case- or list-wise deletion of cases or mean imputation, and has been shown to perform better than these other approaches to missing data in SEM (Enders & Bandalos, 2001). With FIML, missing data are not imputed; rather, likelihood functions are derived for individuals based on all available data and these data are then used to estimate parameters for all data points (Enders & Bandalos, 2001).

Mplus uses FIML for data that is missing completely at random, data missing at random, and data not missing at random, and is admissible with WSLMV estimation as long as the missingness is a function of the observed covariates and not the observed outcome (Muthén & Muthén, 2012). In the case of this study, it is unlikely that much if any of the missingness in the data are due to either of the outcomes under consideration (children's and mothers' PA). In Mplus, missingness is not allowed for observed covariates unless they are brought into the model and estimated (Muthén & Muthén,

2012). In this study the observed covariates (e.g., race/ethnicity, family structure, and mothers' depressive symptoms) are brought into the model by entering them on a line of code so that distributional assumptions can be made about them and FIML can be used.

Normality. Ideally, data used in SEM is normally distributed; however these data contains a combination of continuous and categorical indicators that are not necessarily normally distributed. The WSLMV estimator used by Mplus for categorical data adjusts for the non-normal distributions associated with categorical data that are treated as continuous.

Sample Size. As SEM is based on covariances that are less stable when estimated by small samples, larger sample sizes are preferred for SEM (Ullman, 2006). While there is no agreed upon sample size for SEM, generally more than 200 cases are required, and more may be necessary depending on the complexity of the model and the expected effect size (Fritz & MacKinnon, 2007). Given that there are 200 or more degrees of freedom in each of the models in this study, the number of participants in the GROW data used in this research study (n=2,750) provides sufficient power for the analyses (MacCallum et al., 1996).

Calculation of Standardized Estimates. Mplus offers three options for standardized outputs (Muthén & Muthén, 2012). As this study has a continuous dependent variable, the STDYX output, which produces coefficients standardized on both independent and dependent variables, is reported.

Description of Variables. The observed indicators making up the hypothesized mediating factor PNS were explored in the confirmatory factor analysis described in

Chapter 3. The additional variables used in this phase of the analyses are presented in Table 4.1.

Descriptive Analyses. As discussed in Chapter 1, the sample for this study consists of a sample of 2,750 mothers from California, surveyed in 2012-2013. This aspect of the study involves investigation of the influence of several independent indicators, grouped into factors on children's and mothers' PA. The descriptive statistics for the indicators used in this portion of the study are described in Table 4.1, followed by bivariate analyses of categorical variables (Table 4.2), continuous variables (Table 4.3) and latent factors (Table 4.4).

Table 4.1 Descriptive analysis of indicators (grouped by latent factor), covariates and outcomes, *n*=2750

Indicators of Household Socioeconomic Position (HSEP)	**Variable name in SEM Figures**	**Frequency**	**Weighted %**
Mothers' Education	*reduc*		
Never attended school		1053	0.7
8th grade or less		145	10.3
Some high school		811	9.9
High school graduate or equivalent		255	21.9
Some college		272	22.9
College graduate or more		200	33.8
Missing		14	0.6
Household Income as % of Federal Poverty Level	*inccat*		
0-100%		742	31.6
101-200%		480	18.5
201-300%		291	10.3
301-400%		261	8.5
>400%		712	20.7
Missing		264	10.5
Food Security	*fss*		
Food secure		2145	76.0
Low food security		399	16.2
Very low food security		182	6.9
Missing		24	1.0
Homeownership	*homeown*		
Homeowner		1347	43.7
Does not own home		1371	55.0
Missing		32	1.3
Indicators of Park Availability/Safety			
Feel comfortable going to park in daytime	*nparksafe*		
Strongly agree		1030	34.2
Agree		1426	54.5
Disagree		204	8.2
Strongly disagree		61	1.9
Missing		29	1.2
Good parks in neighborhood	*nparks*		
Strongly agree		970	32.3
Agree		1397	53.4
Disagree		272	10.4
Strongly disagree		82	2.6
Missing		29	1.2

Table 4.1 Continued

Indicators of Neighborhood SEP (by census tract)		**Mean**	**SD**
% Adults aged 25+ graduated from college	*colgrad*	29.24	20.19
% Adults age 16+ in civilian labor force unemployed	*unemployment*	7.77	3.84
% Adults in construction/production jobs	*conprod*	21.55	12.66
Median family income (dollars)	*mdfaminc*	75,445	37,115
Median housing value (dollars)	*mdhhval*	524,928	193,729
Covariates			
Child age (years)		6.78	1.52
Mother age (years)		37.08	6.55
Race/ethnicity		**Frequency**	**Weighted %**
Latina		1230	52.8
White		880	24.1
Black		311	6.2
Asian		269	14.4
Other		10	0.5
Missing		50	0.1
Family structure (two parents)			
Mother lives with spouse or partner		2274	83.5
Mother not married or living with partner		462	16.4
Missing		14	0.6
Mothers' depressive symptoms[l]			
No		2390	86.6
Yes		355	13.3
Missing		5	0.1
Child gender			
Female		1328	49.0
Mother's Weight Status			
Mothers with BMI > 30 (obese)		570	21.1
Missing		213	8.9

Table 4.1 Continued			
Outcomes		**Frequency**	**Weighted %**
Children's physical activity (days per average school week child does PA outside of school for ≥ 1 hour)	*cphysact*		
0 days		99	4.1
1-2 days		587	21.9
3-4 days		768	28.4
5-6 days		451	14.9
Every day		718	26.9
Missing		126	3.9
Mothers' physical activity (during the past 30 days)	*mphsysact*		
PA ≤ 1 to 2 days / month (sedentary)		1053	40.3
Light PA 1-2 times / week		145	5.5
Moderate PA 3 times / week		811	29.6
Moderate PA ≥ 5 times / week		255	8.4
Vigorous PA 3 times / week		272	8.8
Vigorous PA 5 times / week		200	6.8
Missing		14	0.6

Table 4.2 Bivariate analyses of categorical exogenous variables and covariates

Variable	**Children's PA**	**Mothers' PA**
Total n	2623	2736
Total	3.42 (SD=1.2)	2.69 (SD=1.6)
Race/Ethnicity	F=13.76, p<0.001***	F=24.01, p<0.001***
n	2577	2686
White	3.55 (0.039)	3.16 (0.057)
Latina	3.48 (0.036)	2.41 (0.042)
Asian	2.92 (0.072)	2.58 (0.107)
Black	3.24 (0.073)	2.53 (0.091)
Family Structure	F=3.675, p=0.06	F=7.705, p=0.005**
n	2610	2723
Mother lives w/ spouse/partner	3.40 (0.026)	2.73 (0.034)
Mother does not live w/ spouse/partner	3.52 (0.060)	2.50 (0.073)
Child Gender	F=5.119, p=0.02*	
n	2623	
Female	3.36 (0.034)	n/a
Male	3.47 (0.033)	
Mother's Depression Symptoms	F=0.132, p=0.72	F=7.212, p= 0.007**
n	2618	2731
Yes	3.40 (0.071)	2.47 (0.079)
No	3.43 (0.025)	2.72 (0.034)
Mother's Obesity Status		F=63.17, p<0.001***
n	n/a	2524
Obese, BMI ≥ 30	n/a	2.25 (0.060)
Not obese, BMI < 30	n/a	2.87 (0.038)
Owns home	F=2.970, p=0.09	F=74.73, p<0.001***
n	2593	2705
Yes	3.38 (0.032)	2.95 (0.045)
No	3.46 (0.035)	2.42 (0.042)
Been a victim of violence	F=0.328, p=0.57	F=0.224, p=0.64
n	2609	2723
Yes	3.46	2.65
No	3.42	2.69
Had anything stolen from home	F=0.091, p=0.76	F=1.626, p=0.20
n	2610	2724
Yes	3.44	2.58
No	3.42	2.7

[1] Calculated using one-way ANOVA, p<0.001***, p<0.01** and p<0.05*

Table 4.3 Bivariate correlations of continuous exogenous variables and covariates

Individual-Level Variables		**Children's PA**	**Mothers' PA**
Child's age			
	n	2623	2736
	Pearson Correlation	-.023	.007
	Sig. (2-tailed)	.245	.719
Mother's age			
	n	2623	2736
	Pearson Correlation	-.037	.053**
	Sig. (2-tailed)	.059	.005
Mother's educational attainment			
	n	2612	2725
	Pearson Correlation	-.057**	.200***
	Sig. (2-tailed)	.004	.000
Household income as % of Federal Poverty Level			
	n	2369	2475
	Pearson Correlation	-.063***	.215***
	Sig. (2-tailed)	.002	.000
Food security			
	n	2600	2712
	Pearson Correlation	.013	-.114***
	Sig. (2-tailed)	.500	.000
Safety of neighborhood from crime			
	n	2620	2712
	Pearson Correlation	.017	0.082***
	Sig. (2-tailed)	.384	.000
Feel comfortable going to the park in the daytime			
	n	2595	2709
	Pearson Correlation	-.021	-.116***
	Sig. (2-tailed)	.293	.000
Good parks in neighborhood			
	n	2595	2709
	Pearson Correlation	-.008	-.088***
	Sig. (2-tailed)	.696	.000

Table 4.3 continued

Neighborhood-Level Variables		
% Adults aged 25+ graduated from college		
n	2623	2736
Pearson Correlation	-.030	.202***
Sig. (2-tailed)	.121	.000
% Adults age 16+ in civilian labor force unemployed		
n	2623	2736
Pearson Correlation	.025	-.125***
Sig. (2-tailed)	.203	.000
% Adults in construction/production jobs		
n	2623	2736
Pearson Correlation	.037	-.184***
Sig. (2-tailed)	.061	.000
Median family income (dollars)		
n	2623	2736
Pearson Correlation	-.021	.192***
Sig. (2-tailed)	.275	.000
Median housing value (dollars)		
n	2608	2720
Pearson Correlation	-.023	.175***
Sig. (2-tailed)	.248	.000

[1] Calculated using bivariate correlations with Pearson's r, $p<0.001$***, $p<0.01$** and $p<0.05$*

Table 4.4 Correlation matrix of latent factors and exogenous variables

	Children's PA	Mothers' PA	PNS	Household SEP	Neighborhood SEP	Park Availability / Safety
Children's PA	1.0					
Mothers' PA	0.080 (0.043)	1.0				
PNS	0.043 (0.025)	0.170 (0.024)*	1.0			
Household SEP	-0.085 (0.024)*	0.234 (0.023)*	0.551 (0.022)*	1.0		
Neighborhood SEP	-0.060 (0.022)*	0.197 (0.021)*	0.504 (0.019)*	0.705 (0.016)*	1.0	
Park Availability/ Safety	0.016 (0024)	0.103 (0.021)*	0.719 (0.015)*	0.405 (0.021)*	0.448 (0.018)*	1.0

Children's PA Mediated by PNS

Testing the hypothesized model for children's PA begins with a test of the measurement model, in which the exogenous variables covary with one another but no structural paths between them are specified. After arriving at a suitable measurement model the structural paths demonstrating directional relationships between the factors are added to create the full SEM.

Measurement Model

The hypothesized measurement model for children's PA (*cphysact*) contains three exogenous latent factors representing household socioeconomic position (HSEP), neighborhood socioeconomic position (NSEP) and availability and safety of parks (Parks). Each of these latent factors consists of 2-5 observed indicators as described in Table 4.1. All indicators were coded to load positively onto the factors; for example, all

the household SEP indicators are coded for higher values to indicate higher SEP. The measurement model also includes the hypothesized mediating factor PNS brought forward from Aim 1 (described in Chapter 3). Each of these was evaluated in terms of the factor loadings and significance of the factor loadings, in addition to the model fit indices and modification indices (suggestions for modifications to the model).

The dependent variable of interest is a single observed indicator for children's PA, measured using the question "During an average school week, how often does this child play outdoors or do activities such as sports or gymnastics for at least an hour? Please do not include activities during regular school hours." The response set for this question is a 5-point scale, ranging from a 1 for "0 days a week" to a 5 for "every day." As the outcome is a single observed indicator and there is no need to evaluate its factor loadings or covariances, it is thus not included in the measurement model. The measurement model is displayed in Figure 4.1, followed by the hypothesized structural model in Figure 4.2. Each of these models was tested in SEM using Mplus v.7 (Muthén & Muthén, 2012). Modifications to the models were evaluated as to their statistical and theoretical impact and incorporated where sufficiently supported. The final structural model showing significant paths is presented in Figure 4.3.

Structural Model

The hypothesized structural model, presented in Figure 4.2, adds structural paths from each of the exogenous factors (HSEP, NSEP and Parks) to the outcome of interest, children's PA (*cphysact*). The model also estimates indirect effects from the mediation pathways to *cphysact* through the hypothesized mediator, PNS. The indirect effect is the

degree of mediation. The "model indirect" analysis in Mplus determines if this mediation effect is statistically significant. The direct and indirect effects are reported in the results.

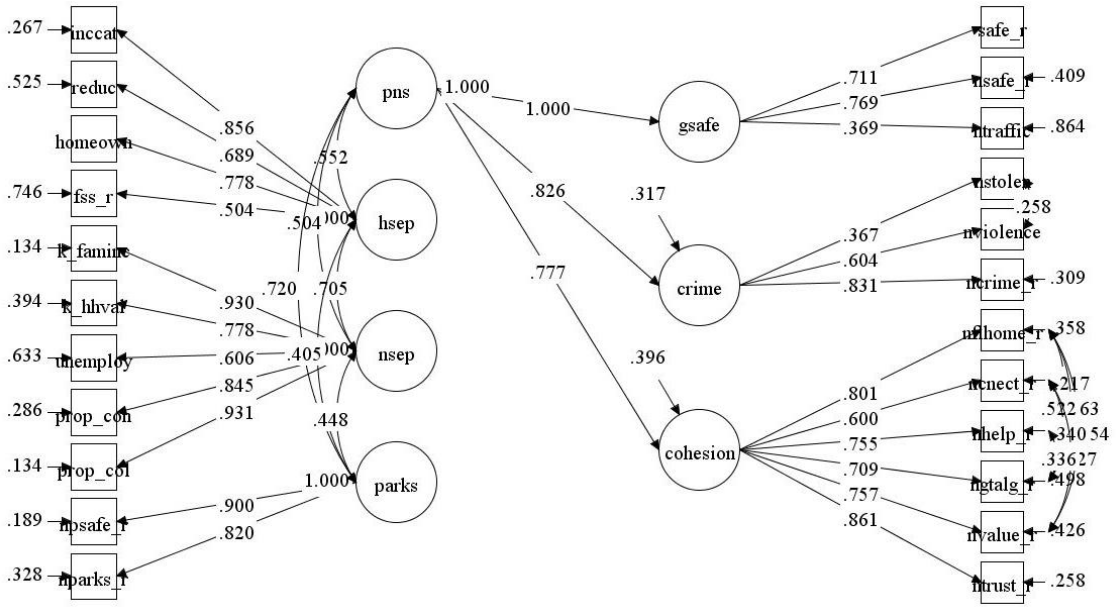
Knowing that these hypothesized relationships are not occurring in isolation, a number of covariates are controlled for in the model by regressing the mediator (PNS) and the outcome (*cphysact*) on each of the covariates: mothers' race/ethnicity, mothers' age, children's age, children's gender, mothers' depressive symptoms and family structure. The structure and description of the covariates is described in Table 4.1. All of the covariates are allowed to covary with one another and the independent latent factors. A set of dichotomous dummy variables was created for race/ethnicity in the categories Latina and other. The other category includes the participants identifying as Black, Asian or Native American/Alaskan Indian or who are missing race/ethnicity data. These categories were collapsed to ensure adequate cell sizes for the analyses. White race/ethnicity was chosen as the referent category and was therefore not listed in the regression equations.

Results

Measurement Model. The modified measurement model performs adequately, with a χ^2 =1173.53 (214), p<.01 (χ^2/df =5.48). The RMSEA was 0.040 (.038,.043). On the relative fit statistics, which compare the hypothesized model to an estimated model, the Comparative Fit Index was .939 and the Tucker Lewis Index was 0.928. Scores of 0.95 or higher are most desirable on these indices, however many studies have used 0.90 or higher as a cut-point (Byrne, 2000). No modifications that made conceptual sense were suggested by the modification indices in the Mplus output, and therefore no

modifications were made to the measurement model. In terms of factor loadings, all observed indicators loaded significantly onto their hypothesized factors in the expected direction, and all loaded on their hypothesized factors at 0.369 or higher.

Figure 4.1. Measurement model for PNS mediation models, showing standardized estimates, all paths significant at p<.001.



Structural Model. Standardized and unstandardized results of the structural model for children's PA are presented in Table 4.5. The structural model showing all paths is presented in Figure 4.2, followed by a model showing only significant paths in Figure 4.3.

Model Fit. The structural model fits acceptably, with χ^2=1726.45 (366), p<0.001, χ^2/df = 4.72. RMSEA for the model is 0.037 (0.035,0.039), with a CFI = 0.939 and TLI = 0.923.

Paths. Of the three exogenous factors, only household SEP (HSEP) had a significant, negative direct relationship to children's PA (p=0.017), and this relationship was partially mediated by PNS (p=0.013). The path from park availability/safety (Parks) to children's PA was significantly fully mediated by PNS (p=0.006). The indirect path from neighborhood SEP to children's PA through PNS was not statistically significant (p=0.091). The significant paths with their standardized estimates are shown in Figure 4.3. The R^2 values for the model suggest that 61% of the variance in PNS is accounted for by the model, but only 4.5% of the variance in children's PA. This would suggest that although the model fits the data well, the results should be interpreted cautiously, as practical significance may be limited.

Covariates. Of the covariates controlled for in the model (mothers' race/ethnicity, mothers' age, children's age, children's gender, mothers' depressive symptoms and family structure), mothers' having positive indicators for depression had lower PNS (-0.174, p<.001). The Latina racial/ethnic group had higher PNS (0.092, p=0.028) and child age was positively associated with PNS (0.024, p=0.013). None of

the other covariates were significantly related to PNS. In terms of children's PA, male gender was related to higher PA (0.031, p=.018) and the Latina and other race/ethnicity categories had significantly lower levels of children's PA than the mother's in the White race/ethnicity referent group (-0.266, p=0.001 for Latinas, -0.524, p<.001 for other race/ethnicity).

Table 4.5 Standardized (β) and unstandardized (B) path estimates for structural model of children's PA mediated by PNS

Direct Effects	**β**	**B**	**S.E.**	**P-Value**	**R^2**
PNS on					0.610
Household SEP	0.313	0.162	0.026	<.001	
Neighborhood SEP	0.073	0.016	0.008	0.039	
Parks	0.578	0.671	0.034	<.001	
cphysact on					0.045
PNS	0.136	0.236	0.086	0.006	
Household SEP	-0.126	-0.113	0.047	0.017	
Neighborhood SEP	-0.048	-0.018	0.014	0.198	
Parks	-0.017	-0.034	0.081	0.672	
Indirect Effects					
Household SEP→PNS→ *cphysact*	0.043	0.038	0.015	0.013	
Neighborhood SEP→PNS→ *cphysact*	0.010	0.004	0.002	0.091	
Parks →PNS→ *cphysact*	0.078	0.158	0.058	0.006	

Figure 4.2 Structural model for children's PA, showing standardized estimates for all paths[1]

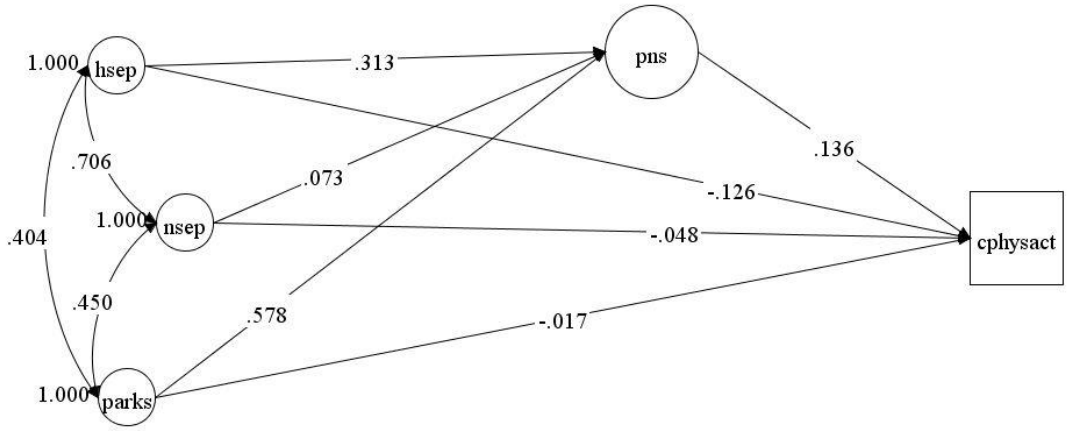
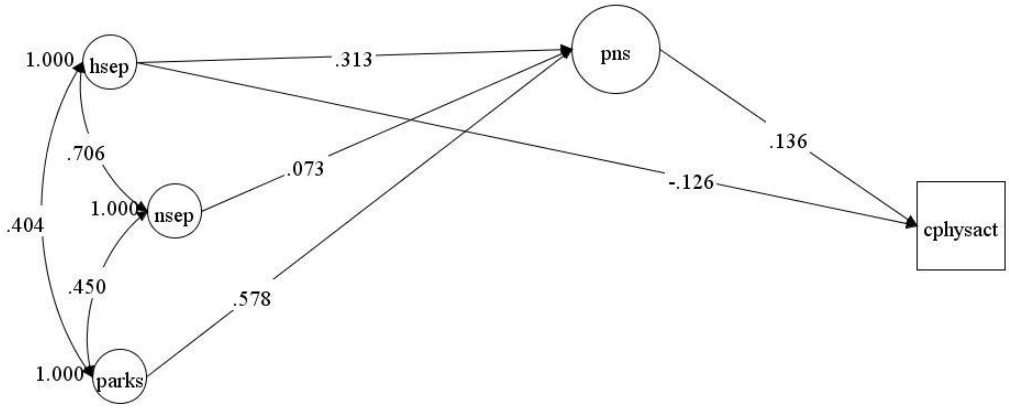


Figure 4.3 Final structural model for children's PA, standardized estimates, showing only significant paths[1]



[1]Covariates: *family structure, mothers' depressive symptoms, children's age, mothers' age, children's gender, mothers' race/ethnicity*

Methods for Test of Gender Invariance

Introduction. The purpose of this section is to present the results of invariance tests used to assess whether the measurement and structural models for children's physical activity (PA) vary by the child's gender. Specifically, this section is concerned with determining whether the significantly higher PA reported by parents of the male children in this sample is due to a difference in the structural mediation model for male vs. female children. Structural equation modeling (SEM) terminology for these tests includes the term *invariant* to mean equivalent and the term *non-invariant* to describe non-equivalence.

Methods: Test of Measurement Invariance. In order for structural invariance to be assessed, measurement invariance across genders must first be supported. Essentially, the measurement model needs to perform in the same way for boys as it does for girls before the analysis to determine if the pathways between factors vary by gender. The process of testing for measurement invariance across gender groups involves comparing a measurement model with all parameters freely estimated (baseline) to iterations of measurement models that are progressively more restrictive (see Table 4.6). These more restricted models are nested within the freely estimated baseline model. First factor loadings were restricted across gender groups to test for weak (factorial) invariance, then factor loadings and item intercepts were restricted to test for strong (scalar) (Meredith & Teresi, 2006).

Table 4.6 Descriptions of progressively restrictive tests of invariance, information from (Meredith & Teresi, 2006)

Test for:	**Also referred to as:**	**Restrictions:**
Weak invariance	Metric or configural, pattern of factorial invariance	Restrict only factor loadings to invariance across groups (measurement)
Strong invariance	Scalar invariance	Restrict factor loadings and item intercepts to invariance (assesses mean difference in latent factors)
Strict invariance	Not commonly done as invariance will typically not hold	Restrict factor loadings, item intercepts and residual variances / disturbances to invariance

As models are progressively restricted it is expected that the fit of the measurement model will worsen. The purpose of the measurement model invariance test is to determine if the fit becomes *significantly* worse, which would suggest that the measurement factor structure is different across gender groups. Comparisons of model fit between these progressively restrictive models are usually done through χ^2 difference tests. However, the scaled χ^2 used in WSLMV estimation requires a scaled χ^2 difference test. Without the scaled χ^2 test the χ^2 differences from WSLMV estimation will not follow a χ^2 distribution. Therefore, to obtain a scaled χ^2 distribution the DIFFTEST command was used to ask Mplus to save a set of derivatives from which the scaled χ^2 differences could be calculated. The DIFFTEST produces a robust χ^2 test which was

used to determine if the fit significantly decreases as models were progressively constrained.

Methods: Test of Structural Invariance. The purpose of the invariance test of the structural model is to determine whether children's gender moderates the structural model for children's physical activity. In this model mothers' PNS partially mediated the path from household socioeconomic position (HSEP) to children's physical activity. The mothers of male children reported significantly higher levels of children's physical activity than mothers of female children (.047, p=.033). To this end, a two-group (male vs. female) invariance test of the final structural model was conducted to assess if the structure of the PNS mediation model is impacted by gender.

The structural model is tested for invariance across gender groups in much the same way as the measurement model. The freely estimated baseline model was compared to a restricted model, where all the structural paths between latent factors are constrained to equality across gender groups, using the DIFFTEST function in Mplus. A significant decrement in fit would indicate non-invariance across gender groups. The restricted models are nested within the freely estimated baseline model.

Results for Test of Invariance

Measurement model. As demonstrated previously, the measurement model within which all the parameters are freely estimated fits well. In the first iteration of restrictions, where the factor loadings are restricted across genders, the DIFFTEST results demonstrate that there was not a significant decrement in fit (Table 4.7). Therefore the factor structure does not vary by gender group and the process of

increasing restrictions in a subsequent, more restrictive test is indicated. In the second iteration of restrictions, where the factor loadings and the item intercepts are restricted to equivalence, there is still not a significant decrement in fit compared to the freely estimated model. This suggests there is no difference in factor structure between the male and female children, allowing further tests examining structural invariance between the gender groups.

Structural Model. The test of invariance for the structural model compared the freely estimated structural model to a model where all structural parameters were constrained to equality across groups. The χ^2 test for difference results indicated no significant decrement in fit, χ^2=25.23 (19) p=0.15, in the constrained structural model. These results suggest that gender does not significantly moderate the structural model for children's physical activity.

Table 4.7. Results of χ^2 test for difference in the measurement model comparing restricted structural model to the freely estimated baseline measurement model

	RMSEA	CFI	TLI	χ^2 test for difference
Measurement Invariance				
Baseline – no constraints	0.04	0.939	0.928	n/a
Factorial invariance	0.033	0.958	0.952	19.262 (df=17); p=0.32
Scalar invariance	0.031	0.961	0.958	35.861 (df=36); p=0.48
Structural Invariance				
Baseline – no constraints	0.03	0.961	0.958	n/a
Scalar invariance	0.024	0.973	0.972	25.23 (df=19); p=0.15

Mothers' PA Mediated by PNS

Methods

The methods for the mothers' PA models are very similar to those described for the children's models. The measurement model is identical (Figure 4.1). The

hypothesized structural model is identical with the exception of the outcome variable, mothers' physical activity (*mphysact).* All of the covariates from the children's PA model are used again (family structure, mothers' depressive symptoms, children's age, mothers' age, children's gender, mothers' race/ethnicity). An additional covariate for mother's obesity status, computed by having a BMI ≥ 30, was added to the mother's PA model.

Results

Measurement Model. The hypothesized measurement model for the mothers' PA analysis is identical to the model for children's PA, presented in Figure 4.1, and the results do not differ.

Structural Model. The standardized results of the structural model are presented in Table 4.8 and in Figures 4.4 (all paths) and 4.5 (only significant paths). As with the children's model, the standardization STDYX was chosen because of the continuous outcome variable. While model fit is adequate χ^2=1517.67 (273), PNS was not a significant contributor to *mphsyact* and none of the estimates of indirect effects were significant (Table 4.8). Additionally, the R^2 for mothers' PA demonstrates the model is estimating very little of the variance (7.8%) in the mothers' PA outcome. As such, this model is not supported. However, the fit of the model suggests that there may be promise in the structure. Therefore examinations of new models repurposing some aspects of this structural model in an exploratory phase of work was conducted.

Table 4.8 Standardized (β) and unstandardized (B) path estimates for mothers' PA structural model with PNS as a mediator

Direct Effects	β	B	S.E.	P-Value	R^2
PNS on					0.610
Household SEP	0.313	0.162	0.027	<.001	
Neighborhood SEP	0.073	0.016	0.008	0.041	
Parks	0.577	0.669	0.034	<.001	
mphysact on					0.078
PNS	0.081	0.184	0.102	0.070	
Household SEP	0.191	0.225	0.062	<.001	
Neighborhood SEP	0.060	0.029	0.017	0.088	
Parks	-0.052	-0.136	0.093	0.144	
Indirect Effects					
Household SEP→PNS→ *mphysact*	0.025	0.030	0.017	0.074	
Neighborhood SEP→PNS→ *mphysact*	0.006	0.003	0.002	0.175	
Parks →PNS→ *mphysact*	0.047	0.123	0.068	0.071	

Figure 4.4 Structural model for mothers' PA, showing standardized estimates for all paths[1]

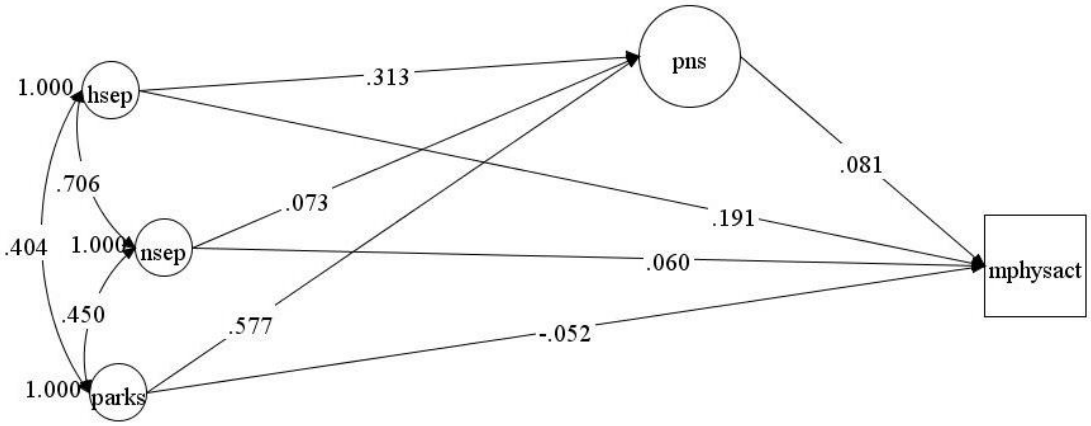
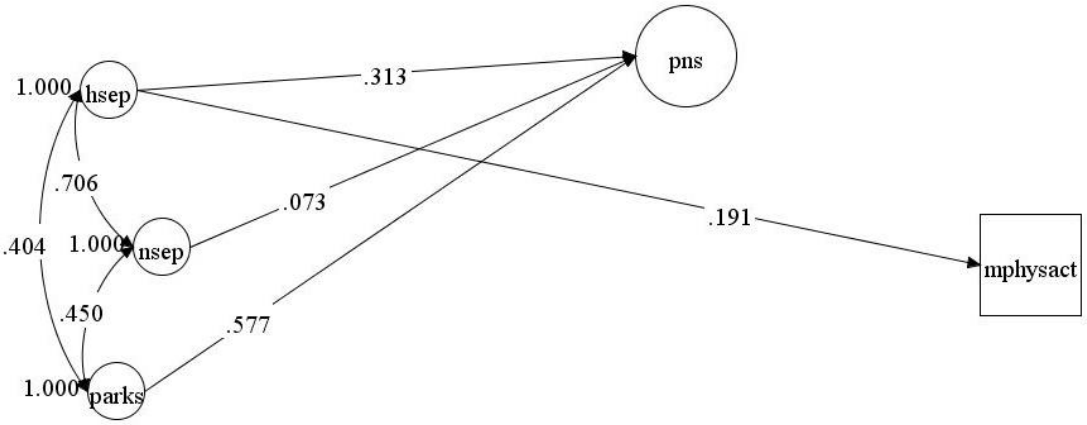


Figure 4.5 Structural model for mothers' PA, standardized estimates, showing only significant paths[1]



[1]Covariates: *mothers' obesity status, family structure household, mothers' depressive symptoms, children's age, mothers' age, children's gender, race/ethnicity*

Exploratory Models with Social Cohesion as a Mediator

Given the support for the influence of social cohesion on mothers' and children's PA in the literature, revised models with only the social cohesion aspect of PNS as a mediator were tested. In this exploratory analysis the latent factor estimating safety from crime (Crime) in the original models is included in the exploratory model as an exogenous factor. A correlation matrix of latent factors and endogenous variables for the exploratory social cohesion models is provided in Table 4.9 These substantial changes require analysis of a new measurement model, shown in Figure 4.6. The exploratory structural models for children's PA are shown in Figures 4.7 and 4.8, and the models for mother's PA are shown in Figures 4.9 and 4.10.

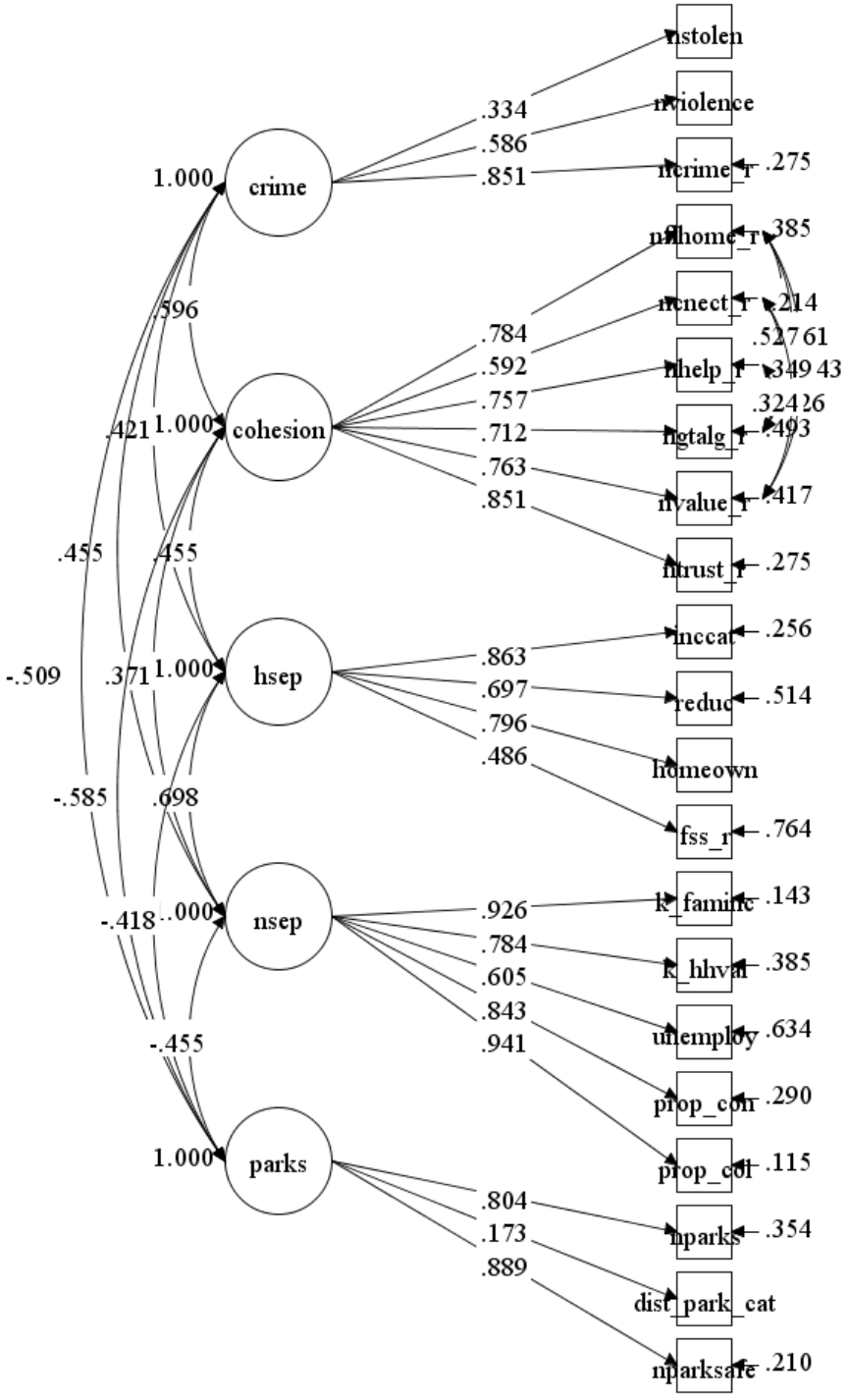
Measurement model. The measurement model for the social cohesion mediation structures fits well, χ^2=984.412 (172), χ^2/df = 5.72, RMSEA = .042 (.039, .044), CFI = .941 and TLI = .928. All indicators load significantly and in the correct direction on the factors to which they are assigned (Figure 4.6).

Table 4.9 Correlation matrix of latent factors and endogenous variables for exploratory social cohesion models

	Children's PA	Mothers' PA	Social Cohesion	HSEP	NSEP	Parks	Safety from Crime
Children's PA	1.0						
Mothers' PA	0.080 (0.043)	1.0					
Social Cohesion	0.056 (0.023)**	0.158 (0.022)***	1.0				
HSEP	-0.085 (0.024) ***	0.234 (0.023)***	0.457 (0.021)***	1.0			
NSEP	-0.060 (0.022)*	0.197 (0.021)***	0.381 (0.020)***	0.705 (0.016)***	1.0		
Parks	0.016 (0.024)	0.103 (0.021)***	0.575 (0.014)***	0.405 (0.021)***	0.448 (0.018)***	1.0	
Safety from Crime	0.006 (0.026)	0.086 (0.025)**	0.602 (0.023)***	0.426 (0.028)***	0.458 (0.023)***	0.517 (0.024)***	1.0

* $p<.0.05$, **$p<0.01$,*** $p <0.001$

Figure 4.6 Measurement model for mothers' PA mediated by social cohesion



Structural Model. The exploratory models examine the role of social cohesion as a mediator between latent factors (safety from crime, availability/safety of parks, and individual and neighborhood-level SEP factors) and children's and mothers' PA. These models were run with the same covariates as the previous structural models: family structure, mothers' depressive symptoms, children's age, mothers' age, children's gender, mothers' race/ethnicity, and mother's obesity status in the mothers' model.

Exploratory Results: Children's PA Mediated by Social Cohesion

The exploratory model testing social cohesion as a mediator in the paths to children's PA demonstrated a model fit very similar to the PNS mediation structural model (see Table 4.10 for model fit statistics presented side by side). In this model only household SEP demonstrated a significant relationship directly to children's PA, which was partially mediated by social cohesion; all other paths from exogenous factors to children's PA were fully mediated by social cohesion. This model explains only 4.5% of the variance in children's PA, very similar to the 4.4% explained in the PNS mediation structure.

Table 4.10 Model Fit Statistics for PNS and social cohesion mediation models for children's PA

	PNS mediation	social cohesion mediation
χ^2 (df)	1726.45 (366)	1517.57 (273)
χ^2/df	4.72	5.55
RMSEA	0.037	0.041
90% CI	(0.035, 0.039)	(0.038, 0.043)
CFI	0.939	0.938
TLI	0.923	0.915

Table 4.11 Standardized (β) and unstandardized (B) path estimates for children's PA structural model with social cohesion (SC) as a mediator

Direct Effects	β	B	S.E.	P-Value	R^2
Social Cohesion on					0.494
Household SEP	0.225	0.088	0.019	<0.001	
Neighborhood SEP	-0.113	-0.018	0.006	0.002	
Parks	0.334	0.305	0.024	<0.001	
Safety from Crime	0.377	0.528	0.071	<0.001	
cphysact on					0.044
Social Cohesion	0.107	0.244	0.083	0.003	
Household SEP	-0.112	-0.100	0.044	0.805	
Neighborhood SEP	-0.033	-0.012	0.014	0.024	
Parks	0.014	0.030	0.067	0.387	
Safety from Crime	-0.010	-0.031	0.127	0.652	
Indirect Effects					
HSEP→SC→ *cphysact*	0.024	0.021	0.009	0.016	
NSEP→SC→ cphysact	-0.012	-0.004	0.002	0.035	
Parks→SC→ *cphysact*	0.036	0.074	0.026	0.004	
CRIME→SC→ *cphysact*	0.040	0.129	0.047	0.006	

Figure 4.7 Structural model for children's PA mediated by social cohesion, standardized estimates, showing all paths[l]

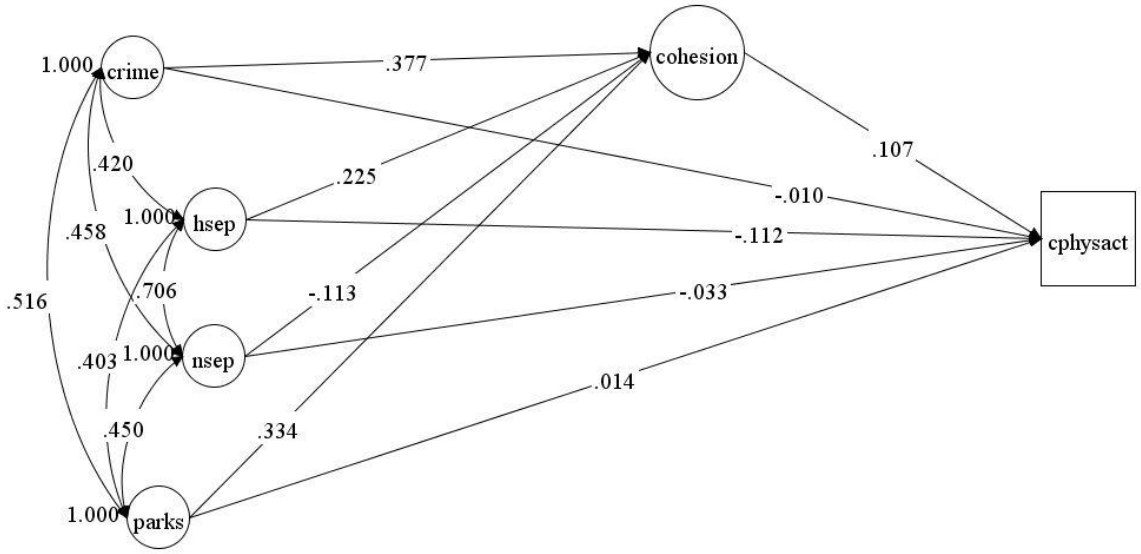
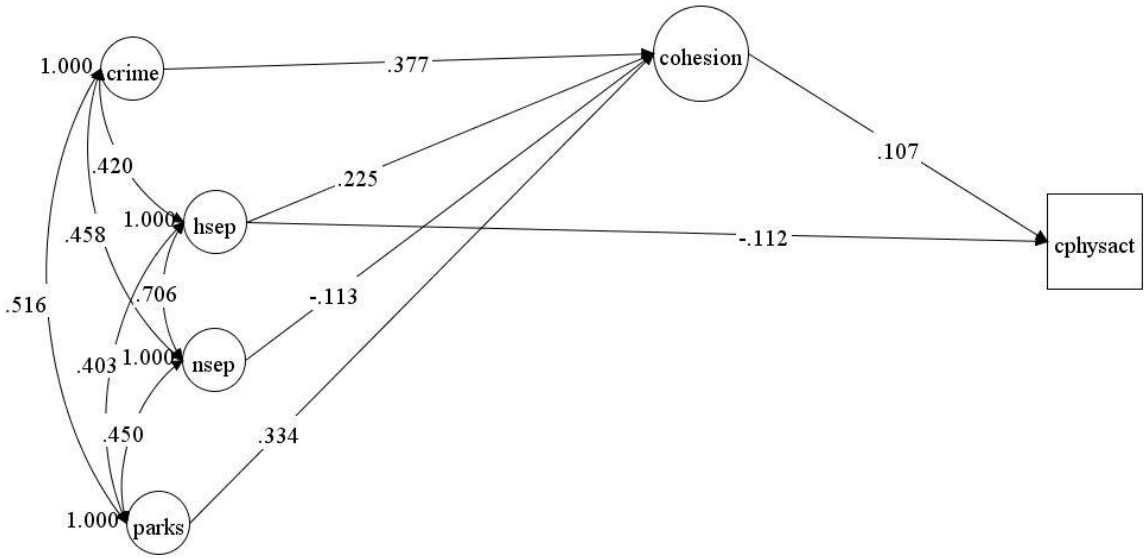


Figure 4.8 Structural model for children's PA mediated by social cohesion, standardized estimates, showing only significant paths[l]



[l]Covariates for both models: family structure household, mothers' depressive symptoms, children's age, mothers' age, children's gender, mothers' race/ethnicity

Exploratory Results: Mothers' PA Mediated by Social Cohesion

The exploratory social cohesion mediation model for mothers' PA has very similar fit statistics to the PNS mediation model (Table 4.12). Additionally, all direct paths are significant, with the exception of the path from Parks to mothers' PA (Table 4.13). All indirect paths are also significant.

Covariates significant to social cohesion in this model included a negative association to other race/ethnicity compared to White race/ethnicity (-0.062, p=0.008), lower assessments of social cohesion for mother's positive on the depression symptom questions (-0.048, p=0.013), and a positive association with child's age (0.041, p=0.036). Mother's PA was also lower for members of the other race/ethnicity category (0.091, p<0.001), mothers with higher age (-0.092, p<0.001) and mothers who were obese (-0.074, p=0.004).

This model appears to be well supported by the data and is a better estimation of plausibly causal relationships leading to mothers' PA. However the R^2 values for mother's PA remain low, suggesting that the social cohesion model only explains 8.3% of the variance in mother's PA.

Table 4.12 Model Fit Statistics: PNS and social cohesion mediation models for mothers' PA

	PNS mediation	Social Cohesion mediation
χ^2 (df)	1726.45 (366)	1538.34 (288)
χ^2/df	4.72	5.34
RMSEA	0.037	0.040
90% CI	(0.035, 0.042)	(0.038, 0.042)
CFI	0.939	0.940
TLI	0.923	0.915

Table 4.13 Standardized (β) and unstandardized (B) path estimates for mothers' PA structural model with social cohesion (SC) as a mediator

Direct Effects	β	B	S.E.	P-Value	R^2
Social Cohesion on					0.494
Household SEP	0.377	0.090	0.019	<0.001	
Neighborhood SEP	0.229	-0.018	0.006	0.002	
Parks	-0.112	0.304	0.024	<0.001	
Safety from Crime	0.334	0.526	0.070	<0.001	
mphysact on					0.083
Social Cohesion	0.115	0.344	0.104	0.001	
Household SEP	-0.088	0.230	0.060	<0.001	
Neighborhood SEP	0.196	0.044	0.018	0.014	
Parks	0.089	-0.072	0.076	0.345	
Safety from Crime	-0.026	-0.367	0.160	0.022	
Indirect Effects					
HSEP→SC→ *mphysact*	0.026	0.031	0.011	0.006	
NSEP→SC→ *mphysact*	-0.013	-0.006	0.003	0.024	
Parks→SC→ *mphysact*	0.038	0.105	0.032	0.001	
CRIME→SC→ *mphysact*	0.043	0.181	0.061	0.003	

Figure 4.9 Structural model for mothers' PA mediated by social cohesion, standardized estimates, showing all paths[l]

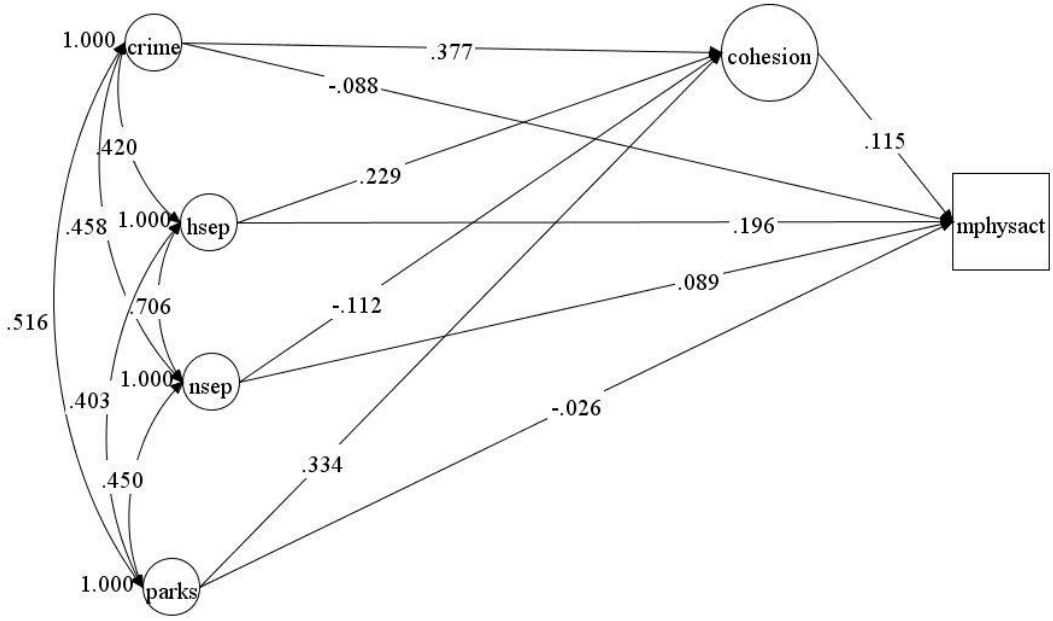
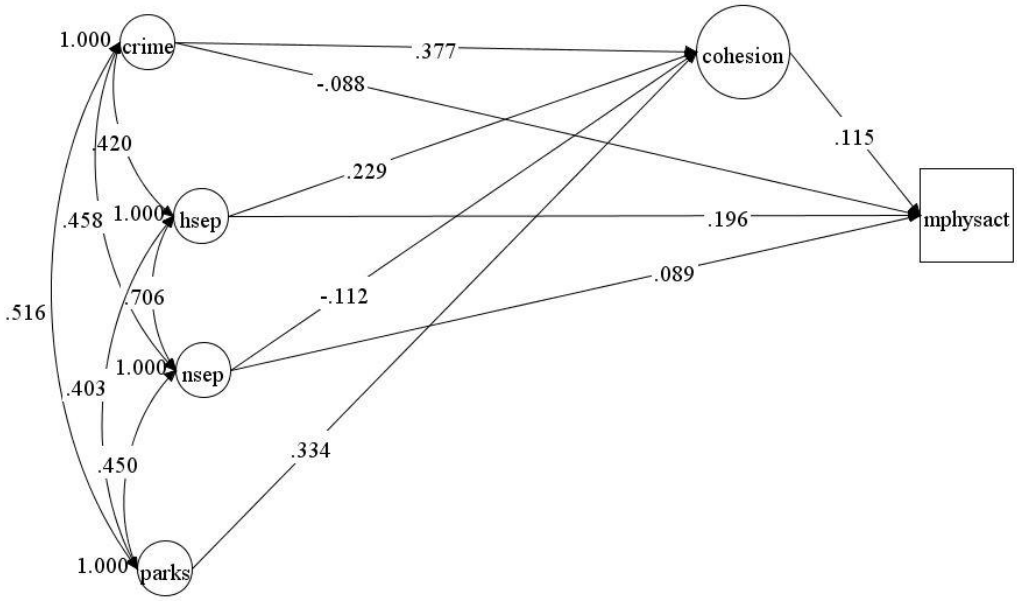


Figure 4.10 Structural model for mothers' PA mediated by social cohesion, standardized estimates, showing only significant paths[l]



[l]Covariates for both models: mother's obesity status, family structure household, mothers' depressive symptoms, children's age, mothers' age, children's gender, mothers' race/ethnicity

Summary of Results for Aim 2 and 3

Children's PA

The analyses for children's PA demonstrated that the measurement model fit the data acceptably well. The structural model, which had adequate model fit, revealed that neighborhood SEP was not a significant predictor of children's PA. Park availability/safety was associated with higher levels of PNS, but was not significantly associated with children's PA. Household SEP was directly, negatively related to children's PA and this relationship was partially mediated by PNS. The path from park availability to children's PA was fully mediated by PNS. In terms of covariates, mothers with depressive symptoms perceived their neighborhoods as less safe. PNS increased with child age, and mothers of Latina race/ethnicity had higher PNS than mothers of other racial/ethnic groups. Male children had higher parental assessments of participation in physical activity, and children of Latina mothers had lower assessments. The other covariates, including two-parent households, and mothers' age, were not significant to either PNS or children's physical activity.

This analysis did not find that neighborhood SEP was related to children's PA, as some other studies have shown (Gordon-Larsen et al., 2006; Greves Grow et al., 2010). This may be due to the accounting for other aspects of the neighborhood in the model, especially all the aspects of social cohesion and perceived safety in the PNS measures. For instance, a study of 680 Chicago children found social cohesion was a significant predictor of PA in a hierarchical regression analysis when controlling for neighborhood SEP (Cradock et al., 2009). In that study, neighborhood SEP was not directly associated

with PA in bivariate analysis. Similar findings also occurred in a primarily low SEP sample of families in the national Fragile Families study, where neighborhood SEP was not directly related to children's PA in binomial regressions, and when controlled in multivariate analyses, collective efficacy (a concept measuring neighbors' ability to work together to solve problems and closely related to social cohesion) was a significant predictor of SEP. The assessment of park availability/safety may also have accounted for some of the variance otherwise accounted for by neighborhood SEP, as studies have shown neighborhoods with lower SEP also have reduced access to quality parks and other recreational outlets, resulting in lower PA attainment (Ding et al., 2011; Sallis et al., 2012).

Test for Gender Invariance

The invariance test of the measurement model confirmed measurement invariance across gender, allowing for the comparison of structural models. When the fully constrained structural model was compared to the freely estimated model, there was no significant change in fit, indicating that children's gender does not significantly moderate the structural model for children's physical activity.

Some other research suggests that assessments of PNS may vary by gender of the child, and that PNS may differentially affect children's levels of physical activity (Gómez et al., 2004) and obesity (Bacha et al., 2010) by gender. While the regression of children's PA on children's gender as a control variable did indicate that male children get significantly more PA in GROW, when boy's and girl's mean PA scores were compared with an independent samples t-test, the difference was significant, t (2567) =

2.24, p=.025, but not clinically meaningful (mean score of 3.47 for boys vs 3.36 for girls). Additionally, the gender covariate in the children's PA models was not significantly related to PNS. One important consideration of this study is that although mothers' in the GROW study are responding specifically about the child they gave birth to at enrollment in MIHA, they (and/or other adults in their household) may have other children. For example, mothers reporting about female children are not necessarily only mothers of girls. The presence of male children in their families may be affecting their PNS and/or their child's PA attainment in ways that are not accounted for in this analysis.

Mothers' PA

Analyses for mothers' PA revealed that although the hypothesized model demonstrated adequate fit, PNS was not a significant predictor of mothers' PA and did not mediate any of the hypothesized relationships.

Exploratory Analyses

Children's PA. Exploratory models assessing just the social cohesion aspect of PNS as a mediator, with a revised measurement model including the latent factor safety from crime as an exogenous factor, had a good fit to the data. In the model for children's PA mediated by social cohesion, model fit was nearly identical to the PNS mediation model. In the PNS model, two of three paths (HSEP and Parks) were significantly mediated by PNS; in the social cohesion mediation model the paths from all four exogenous factors (HSEP, NSEP, Parks and Crime) were significantly mediated by social cohesion. While these models have good model fit, they explain only about 4.5% of the variation in children's PA.

Mother's PA. As with the children's models, model fit was very similar for both the PNS and social cohesion mediation models for mothers' PA. In contrast to the PNS model, in the social cohesion mediation model nearly all the hypothesized paths were significant. Social cohesion was found to partially mediate perceived safety from crime, neighborhood SEP and household SEP pathways to mothers' PA, and fully mediate the relationship between park availability/safety and mothers' PA. This model suggests that social cohesion is an important consideration for mothers' PA and is a better predictor than PNS. The PNS model explained 7.8% of the variance in mother's PA, compared to 8.4% in the social cohesion model. While the model fit is adequate, the low R^2 values indicate that practical application of the findings may be limited.

Chapter 5: Discussion

Introduction

The purpose of this study was to investigate the contributions of individual- and neighborhood-level socioeconomic position (SEP), as well as social and environmental characteristics of neighborhoods, on children's and mothers' participation in physical activity. In particular this study examined how a comprehensive assessment of perceived neighborhood safety (PNS), that included concepts of fear of crime, general safety, traffic and social cohesion, mediated the known relationships between household and neighborhood SEP, the presence and safety of parks, and physical activity. Data from the GROW survey of 2,750 California mothers was used for this research. The study provided multiple measures of both household and neighborhood SEP, participants' subjective ratings of park availability/safety as well as objectively measured distance from their residence to the nearest park, assessments of multiple aspects of perceived safety, and a wealth of demographic data and self-reported levels of physical activity for both respondents and their children.

Discussion of Findings: Aim 1

Aim 1 Summary. The study involved three research aims, the first of which involved using structural equation modeling (SEM) to assess a multivariate measure of PNS through confirmatory factor analysis (CFA). The originally hypothesized model of PNS was composed of four latent factors: General Safety, Play Safety, Safety from Crime and Social Cohesion; each of these factors was composed of a number of indicators described in Chapter 3.

This model demonstrated two significant problems in the first-order factor analysis. First, the indicator for "I often see children play outside in my neighborhood" was found to be an insignificant predictor of perceived safety due to a very low factor loading. Further consideration of this indicator led to the conclusion that agreement with the statement might not indicate a safer neighborhood, and in fact, could potentially indicate a less safe neighborhood for children's play, and it was deleted from the model. Second, the latent factors General Safety and Play Safety were correlated at >1, indicating that they could not remain distinct concepts together in the model. Based on this finding these latent factors were combined into one.

The final model for PNS, assessed in a just-identified second-order factor analysis, accounted for contributions of participants' perceptions of safety from crime, perceptions of general neighborhood safety, perceived safety of neighborhood traffic and social cohesion. The model had a good fit to the data and all of the paths were statistically significant, with sufficient factor loadings in the expected direction. As expected from a just-identified model, the results were nearly identical to the first order factor analysis. This latent factor structure approximating the concept of PNS was supported by the data and was used in the subsequent study analyses.

Aim 1 Discussion. PNS has been examined in many different ways in previous studies of children's PA. Most studies have employed single-aspect definitions assessing fear of crime (Burdette & Whitaker, 2005; Gómez et al., 2004), safety for play (Beets & Foley, 2008; Molnar et al., 2004), or traffic safety (Carver et al., 2005; DeFrancesco et al., 2004; Timperio et al., 2004). A few have used more comprehensive, multi-faceted

assessments of PNS (Lumeng et al., 2006; Weir et al., 2006) more similar to the fuller assessment used in this study.

The conceptualization of PNS arrived at through the CFA analysis in this study is similar to the model presented by Austin, et al. (2002). This is the only other study examining the performance of a multivariate conceptualization of PNS. They present a model of PNS, also analyzed through SEM, assessed with data collected via survey of 232 adults in Louisville, Kentucky and combined with in-person assessments of the housing and neighborhood quality of respondents. While the survey measured perceptions of safety from a crime perspective, asking four questions regarding the need to lock doors, the likelihood of someone breaking into a neighborhood home, the ability to walk at night without fear, and whether property could be left outside without being stolen, it also assessed the contributions of a number of other neighborhood-level social and physical environment factors to PNS. Respondents in the Austin et al. study were also asked about level of satisfaction with people in their neighborhoods, using 4 questions that are similar to the 6 questions comprising the social cohesion scale in GROW. Additionally, Austin et al. measured satisfaction with the physical environment in a manner that differs from GROW, using four questions focused on pride of appearance, litter, space between homes and peace and quiet. Unlike the GROW study, Austin et al. did not assess perceptions of traffic, general safety, park safety or park availability.

The observational data gathered by Austin et al. (2002) assessed the presence of physical incivilities and the general appearance of the neighborhood, as well as the

quality of the respondent's own home. These observational data loaded onto one factor, which they termed *housing quality*. In their study, the respondents' perceptions of both the physical and social environments contributed significantly to PNS, in a manner similar to the results of this study, in that individuals reporting higher assessments of park availability/safety and social cohesion also perceived their neighborhoods as more safe. In the Austin et al. study the observational assessment of "housing quality" (which also encompassed an observational assessment of the neighborhood) was also positively associated with perceived safety through perceptions of the physical environment. While observational assessments were not within the scope of the GROW study, their findings suggest that objective observational assessments are of value to assessing neighborhood conditions. Such assessments allow for determining the effects of those conditions on perceptions of safety, and for accounting for discrepancies between actual conditions and resident's perceptions of those conditions (Austin, et al., 2002, pg. 425).

This analysis of the GROW study adds to the assessment of perceived neighborhood safety in the Austin, et al. study by demonstrating that inclusion of other aspects of safety that are important to children's neighborhood play, including: perceptions of general safety, safety from traffic, and park safety, quality and access, is both possible and supported by a large dataset comprised of an ethnically and economically diverse sample of families. Taken together, both of the studies confirm that the concept of PNS should go beyond crime-focused definitions to include social aspects of the neighborhood. Future studies of effects of PNS on PA and other health outcomes should either include assessments of the neighborhood environment in their definitions of

PNS, as this study and Austin 2002 suggest, or at a minimum, should include those assessments as covariates in their analysis.

Beyond the relationships to PA examined in this research study, understanding how women form assessments of PNS is important to other aspects of health and well-being. Women who perceive their neighborhoods as unsafe may also have lower assessments of overall neighborhood quality (Curtis et al., 2004; Wen et al., 2006), fewer social ties (Douglas D. Perkins, Meeks, & Taylor, 1992), higher depression (Hill & Herman-Stahl, 2002) and higher levels of fear and anxiety (Johnson et al., 2009; Douglas D. Perkins et al., 1992) and problems sleeping (Johnson et al., 2009) than women living in neighborhoods perceived to be safe. Lower assessments of PNS may also contribute to mothers allowing children more TV time (Burdette & Whitaker, 2005; Datar et al., 2013). In summary, PNS is a contributor to many aspects of the well-being of mothers and their children, and assessment of PNS has implications for children's PA as well as other mental and physical health outcomes. Comprehensive assessments of PNS should therefore be considered in research studies examining PA and other health outcomes.

Discussion of Findings: Aims 2 and 3

The second research aim involved testing whether this measure of PNS mediates the relationships between household SEP, neighborhood SEP, the quality and proximity of neighborhood parks and PA outcomes. In research Aim 2, the measurement model and structural model for children's PA was analyzed, and an invariance test was conducted to determine if the structural model varied by gender (girls vs. boys). In Aim 3 the structural mediation model for mothers' PA was tested and revealed that despite

good model fit the mediation paths and direct paths from PNS to PA were not significant. In light of that finding and because of existing evidence in the literature, exploratory models testing only the social cohesion aspect of PNS as a mediator were evaluated.

Aim 2

Aim 2 Summary. The purpose of this research aim was to determine whether the latent factor PNS mediated the pathways from the exogenous factors neighborhood-level SEP, household-level SEP, and park availability/safety to the endogenous indicator for children's PA. The measurement model had a good fit to the data. The structural model, which had adequate model fit statistics, indicated that PNS regressed significantly on all three exogenous factors. Only household SEP had a significant direct relationship to PNS. Estimates of indirect effects indicated that PNS did significantly partially mediate the relationship between household SEP and children's PA. The path from park availability/safety to children's PA was significantly fully mediated by PNS. The gender invariance test revealed that although children's PA does vary significantly by gender, the structure of the model does not. A post-hoc independent samples t-test revealed that the mean difference in children's PA by gender was statistically, but not meaningfully, significant.

These findings demonstrate that within the sample for GROW, children's PA was significantly positively associated with household SEP, and this relationship was partially mediated by mothers' PNS. Additionally, availability and safety of parks in the neighborhood contributed significantly to mothers' PNS, which fully mediated the relationship between parks and PA.

Aim 2 Discussion. As has been demonstrated in other studies, the results of this analysis did find that PNS is an important predictor of children's PA (Beets & Foley, 2008; Datar et al., 2013; Lumeng et al., 2006; Weir et al., 2006). PNS partially mediated the relationship from household SEP and fully mediated the park availability/safety factor to PA relationship. Household SEP did directly contribute to children's PA and this effect was partially mediated by PNS; however, this relationship was negative, which was unexpected, as SEP is generally positively associated with PA. In this study neighborhood SEP was not a significant predictor of children's PA. Inverse associations between neighborhood SEP and children's PA have been present in other studies (Gordon-Larsen et al., 2006; Greves Grow et al., 2010; Singh et al., 2008). The associations to SEP may not be significant (or in the case of household SEP, not in the expected direction) in the current study because the structural equation model included many other aspects of the neighborhood in the model, including social cohesion, perceived safety and availability of parks. Other studies have demonstrated that these social and environmental aspects of neighborhoods are predictors of children's PA and are often related to neighborhood SEP (Cradock et al., 2009; Ding et al., 2011; Sallis et al., 2012). In this study they may be accounting for the variance that might otherwise be contributed by neighborhood SEP. Additionally, in nationally representative data, Lee & Cubbin (2003) found that in models controlling for household SEP, neighborhood SEP was no longer a significant predictor of children's PA.

The relationship between park availability/safety and PNS is significant, and PNS fully mediates the relationship to children's PA. This follows patterns found in other

research. For instance, in a study of 4,010 California adolescents participating in the California Health Interview Survey, access to a safe park was significantly positively associated with PA and negatively associated with inactivity, but only for adolescents living in safe neighborhoods with higher household SEP (Babey, Hastert, Yu, & Brown, 2008). Researchers seeking to understand the effects of parks on health should therefore ensure that measures of PNS are included in their research, as the presence of parks may mean very little if potential users do not perceive their neighborhoods to be safe.

Multi-group analyses found that there was no difference in the structural model for children's PA by child gender. Because mothers reporting in GROW may have multiple children, gender differences may not be as pronounced. Additionally, while respondents did report that boys had statistically significantly higher PA than girls, the difference was not practically meaningful.

The results of this study should be interpreted with caution, as the models tested explained less than 4.5% of the variance in children's PA and therefore the practical significance of these findings may be limited. There could be several reasons for the low R^2 values. There may be relevant contributing factors that are not included in the current research study. Nutritional information is not included in this study, but should perhaps be considered in future research. This should include both the self-reported nutrition information in GROW as well as information from the built environment, such as the saturation of fast food outlets and availability of grocery outlets proving fresh food options. Additionally, the amount of PA taking place in the school setting is not accounted for here and may have an impact on the PA outcome of this study. Children

who are getting higher amounts of PA in school may not participate in as much PA outside of schools. This study accounted for perceived park availability and safety, but not for other locations where PA may take place, such as community centers, gymnasiums and other such locations.

Aim 3

Aim 3 Discussion. In research Aim 3, the PNS mediation model was tested with mothers' PA as the endogenous variable. Unlike the children's model, PNS was not a significant predictor of PA among the mothers in this study, nor did it mediate any of the other hypothesized relationships. This aligns with the mixed results of other studies of the effects of PNS on PA in adult samples (Bennett et al., 2007; Brownson et al., 2001; Humpel et al., 2002). According to reviews by Sallis et al. (1997) and Humpel et al. (2002) the lack of a relationship between the two may be due to the ability of adults to leave their neighborhoods to participate in PA, and it may be compounded by the higher rates of obesity and inactivity among adults in lower income neighborhoods (Singh et al., 2008), where PNS is generally also lower. Mother's PA and PNS were significantly correlated in bivariate analyses, but in the structural equation model, only household SEP was significantly directly related to mother's PA. This finding echoes what is known in existing literature: mothers with fewer economic resources are less likely to participate in leisure-time PA, regardless of neighborhood safety.

Exploratory Social Cohesion Mediation Models

In exploratory analyses, the models were re-specified to investigate whether the social cohesion aspect of PNS was a mediator in the relationships to PA. Model

specification changes included evaluating safety from crime as an exogenous factor. This exploratory measurement model had a good fit to the data, very similar to the PNS measurement model.

Children's PA by Social Cohesion. Children's PA was influenced by social cohesion in a manner very similar to the original PNS mediation models. In the exploratory model, perceived safety from crime is used as an exogenous factor, and its effects on children's PA are fully mediated by social cohesion. This results of this model suggest that the social cohesion aspect of PNS was accounting for most of the influence of PNS on PA, and performs equally well as a mediator.

Mother's PA by Social Cohesion. The structural model for mothers' PA mediated by social cohesion had adequate fit to the data, similar to the PNS mediation model. Social cohesion partially mediated the relationships from safety from crime, neighborhood SEP and individual SEP to mothers' PA and fully mediated the relationship from park availability/safety to mothers' PA. This appears to be a better model for predicting mother's PA as compared to the PNS mediation model.

The results of the exploratory models testing social cohesion as a mediator suggest that social cohesion is an essential component of understanding relationships to PA. Strong social cohesion may be able to reduce the socioeconomic, crime and built environment effects neighborhoods have on engagement in PA. This finding is consistent with other studies that have also found social cohesion to be an important factor in PA for adults, and women in particular (McNeill et al., 2006a). Higher levels of social contact and social exchange among members of a socially cohesive community

may lead to the adoption of more healthful behaviors and a culture favoring fitness (Cradock et al., 2009). For example, women who frequently see other women exercising in their neighborhood engage in PA more often (King et al., 2000). Social cohesion may also contribute to higher assessments of park availability/safety (Wen et al., 2006), and contribute significantly to PNS (Austin et al., 2002; Ferreira et al., 2007; Franzini et al., 2008; Sampson & Raudenbush, 2004). Likewise, in the current study, park availability/safety was positively related to assessments of PNS in all three of the structural equation models.

As with the PNS models, the R^2 values estimating the amount of variance accounted for by the social cohesion models for PA is limited. The PNS and social cohesion mediation models performed very similarly, accounting for about 4.5% of the variance in children's PA. The R^2 is a bit higher for the mother's social cohesion models (8.3%) than the PNS mediation model (7.8%), but not in a practically significant way. This better performance of the mothers' models may be due to the model predicting more of the variance, but it could also be due to the difference in the assessment of mother's PA. The children's assessment is focused on simply days per week they get an hour or more of PA, while the mother's assessment accounts for a high variety of activities at various intensities. As discussed previously, there may be some variables not included in the models that perhaps would contribute to PA, including assessments of other places for PA (e.g., gymnasiums, fitness centers) and nutrition information. Given the relatively low R^2, the results of the model should be interpreted cautiously as practical significance may be limited.

In comparing the social cohesion models for mothers and children, one interesting difference is that the direct path from neighborhood SEP to PA is significant for mothers but not children. In the children's model, this path is fully mediated by social cohesion. This may indicate that while social cohesion is important for both parties, it may be particularly important for children, as it can significantly buffer the effects of neighborhood conditions (neighborhood SEP, park availability/safety and crime) on PA for children. Coupled with the negative relationship between neighborhood SEP and social cohesion, these findings indicate that the stronger social cohesion in lower SEP neighborhoods is one of the reasons neighborhood SEP was not directly significant to children's PA.

Study Strengths & Limitations

Limitations

The results of this study should be considered in light of its limitations. Perhaps the most substantial limitation of this study is that the outcome measures for PA attainment are not restricted to PA in the neighborhood. Therefore the impact of neighborhood factors on PA may be underestimated in the current study, as some unknown proportion of mothers and children are surely engaging in PA outside of their neighborhoods. Some researchers suggest engagement in PA outside the neighborhood is likely, especially among adults who do not perceive their neighborhood conditions to be supportive of PA (Sallis et al., 1997). This has been an issue identified by systematic reviews of studies of neighborhood effects on PA (Foster & Giles-Corti, 2008). Another issue regarding assessment of PA in our study concerns the performance of self-report

measures. Assessments of PA using self-report have been unreliable when compared to objective measures of PA (e.g., accelerometers and /or pedometers) (Prince et al., 2008; Troiano et al., 2008). These studies have found self-report measures to be substantially inflated compared to accelerometer about 60% of the time. While it was not within the scope of GROW to measure PA using accelerometers, studies measuring PA objectively may find different effects. The single question measuring children's PA is certainly subject to self-report bias but it does not appear to provide higher estimates of PA than found in the NHANES assessment of accelerometer data analyzed by Troiano et al. (2008). In GROW, mothers reported that 42.3% of their children obtained an hour or more of PA on 5 or more days per week. The NHANES also data also found 42% of children obtained an hour or more of PA (accelerometer measurement periods ranged from 1-4 days) (Troiano et al., 2008).

In terms of mothers' reporting in GROW, the measure of PA used in the study was found to be valid, reliable and quite sensitive to change in levels of PA in a previous evaluation (Kiernan et al., 2013). In GROW, 38.1% of mothers reported sedentary activity, and 26.9% selected moderate PA five times per week or a higher category. This may best approximate achievement of the recommended 150 minutes of moderate PA per week (US Department of Health and Human Services, 2008). A nationally-representative study of over 3,400 adults, found that only 10% of adults were meeting the minimum criteria of 150 minutes a week of moderate activity when measured using an accelerometer (Tucker et al., 2011). In that study, adults self-reported a weekly average of 372 minutes of moderate activity and 45 minutes' of vigorous activity; accelerometers

measured an average of 74 minutes moderate activity and 19 minutes vigorous activity. The authors hypothesize that adults may not accurately be able to classify the intensity of PA, and that they may inflate estimates of their own engagement due to self-report bias, and to a lesser extent, recall bias. Comparison of the GROW findings and the Tucker et al. study findings suggest there may be some self-report bias occurring in the GROW study, but given the high selection of inactivity (nearly 40%), not all the participants appear to be affected.

Previous research has demonstrated disparities in recreational resources, such as parks, community centers, fitness centers and gyms in neighborhoods with lower SEP (Gordon-Larsen et al., 2006; Powell et al., 2006) and these resources were related to PA. The GROW study accounted for park availability but not access to other kinds of recreational facilities (e.g., community recreation centers) that mothers and children might be utilizing for PA or the facilities available within each park.

The analysis of gender invariance in this study was complicated because mothers in GROW could have children of both genders. While mothers were responding about the PA of the index child, their responses to questions about PNS and other neighborhood conditions are not restricted to that child.

GROW includes a large sample representative of women giving birth in 6 California counties. The sample is diverse in terms of race/ethnicity and socioeconomic factors, but generalization of the results to families in other geographic locations may be limited. In addition, cross-sectional research cannot establish causality as the data cannot demonstrate that the independent variables precede the dependent variables in time.

In these analyses, the Black, Asian, missing and other race/ethnicity groups had to be collapsed for the analyses. There were too few members of the Black (*n*=311) Asian (*n*=269), other (*n*=10) and missing (*n*=50) race/ethnicity categories to include them separately as dummy variables. The problem was primarily with cell sizes for the variables measuring experiences of violent and property crime, which were rare among the Asian racial/ethnic group. To address this issue, these three categories were collapsed into a single category that was then used as a dummy variable to control for race in the structural equation models. However, some interpretation of the meaning of race/ethnicity is lost in this process as this group does not represent any one racial/ethnic group.

Strengths

This study also has a number of strengths that warrant discussion. Perhaps the foremost strength is the comprehensive nature of the GROW study. The analyses presented in this research study included multiple measures of SEP at both the individual- and neighborhood-levels; many other studies have used only single-level measures, single indicators or inaccurate substitutes (e.g., health insurance status) (Braveman et al., 2005). GROW also collected data on numerous aspects of safety and the social environment, which allowed for the analysis of the PNS measure tested in Aim 1. Additionally, aspects of the built environment were provided (distance to parks) for this research, and more are forthcoming as the GROW data are finalized, including park acreage and distance to and density of PA-related businesses (e.g., gyms and health clubs).

Secondly, GROW is a large 6-county study of women who originally participated in a state-wide study (MIHA) that was representative of all women giving birth in California from 2003-2007. The response rate for GROW of MIHA participants who could be located (n=5,161) was very high at 74.9%. The sample represents a demographically and socioeconomically diverse group of women and their children, of an ideal age (4 to 10 years) to study risk factors for overweight and obesity. The geocoding accuracy to census tracts for the GROW respondent addresses was very high, at 97%, and the survey data was weighted to ensure data in GROW was representative of the MIHA sample in the GROW counties.

This study investigated the role of PNS from a holistic perspective that included the participant's fear of crime and assessment of social cohesion, with their general perceptions of neighborhood safety and an assessment of perceived traffic safety. Most previous studies of the effects of PNS on PA have investigated only one of these aspects of safety on PA (most commonly fear of crime), even though mothers may consider all of them when making decisions about children's neighborhood play (Carver et al., 2008). This study demonstrated that the aspects of safety and social cohesion taken together could be estimated by a single factor approximating PNS, and as a result suggests that future studies of PNS should include each of these aspects.

Implications for Public Health Services, Providers and Practice

The results of this study support ongoing attention to neighborhood-level effects on individual-level health outcomes. In particular, this study demonstrated that mothers' perceptions of neighborhood safety, when defined in a comprehensive manner consisting

of social cohesion, crime, traffic and general assessments of safety, significantly mediated relationships between household SEP and children's PA and between park availability/safety and children's PA. Impacting mothers' PNS by improving neighborhood social cohesion, reducing crime and perceptions of crime, and addressing dangerous traffic conditions may improve children's engagement in PA.

These neighborhood-level interventions may only be possible through collaborative efforts with multi-disciplinary social service providers, engineering services, law enforcement, community leaders and others. Cross-sector efforts of this nature, although costly to implement, may be more successful than isolated individual level interventions at reducing overweight and obesity. For instance, the Shape Up Somerville initiative is a city wide effort to prevent child obesity in Somerville, Massachusetts (Economos et al., 2007). This initiative takes a collective impact approach, where many separate agencies throughout the city take an active role in supporting the effort, but share in common measurement strategies and outcome goals. The city schools provided healthier food, nutrition education and more physical activity time, while other community agencies incentivized restaurants to provide healthy options, provided discounted gym memberships, repaired sidewalks and crosswalks and encouraged walking to school. The city saw a significant decrease in children's BMI in Somerville compared to control communities after one year. Additionally, improving availability and safety of parks may have a positive effect on PNS and therefore on children's PA.

PNS did not mediate relationships to mothers' PA in this study, but exploratory analysis of a social cohesion mediation model did demonstrate significant effects on mothers' PA. Social cohesion, in addition to positive effects on women's PA, also has other positive effects on the health and well-being of adult women. Interventions that create social cohesion within neighborhoods may have positive effects on PA as well as other individual and neighborhood benefits. However, there is a paucity of research evaluating interventions to improve social cohesion in neighborhoods, despite the consistent research findings linking social cohesion to physical activity. Evaluation of programs working to build social cohesion and other social capital resources is needed. Results from the present study indicate that the presence of safe, quality parks may also contribute to higher social cohesion, and programs to improve park spaces and access are indicated.

Implications for Future Research

The models presented in this study provide valuable information about the roles of household and neighborhood socioeconomic conditions, but the moderate model fit indicates that there may be other constructs that might strengthen our understanding of how PNS and social cohesion mediate relationships to PA. Future studies including recreational resources beyond parks, objective measurement of PA, and objective observation of neighborhood physical conditions, as well as additional aspects of the individual's physical condition (body mass index, other health characteristics) may be able to provide more information about effects on PA. The review of 107 studies of neighborhood environments and PA by Ding et al. found that studies with objectively

measured environmental attributes found more consistent associations to PA (Ding et al., 2011). Some of this work, such as inclusion of body mass index and other health indicators, can be done with future studies of GROW. Additionally, qualitative inquiries into how PNS and social cohesion impact mothers' and children's PA could be especially illuminating and useful for intervention design and implementation. This study found significant relationships between the covariates for race/ethnicity and age and the PNS, social cohesion and PA factors. Future studies of the role of social cohesion and PNS should consider multi-group analyses to assess how these demographic variables may moderate relationships to PA.

Perhaps the most compelling area for future research in this area is to continue clarifying the definition of PNS. PNS should be conceptualized in ways that are comprehensive and attentive to the specific outcome of interest. For instance, studies of PNS as it applies to children's walking and cycling have primarily focused only on traffic safety, even though safety from crime and social cohesion may also be important influences on whether children can walk/cycle in their neighborhoods. Continued research on the role of social cohesion and how it may mitigate crime or other safety issues in a community is also compelling.

Conclusion

The majority of adults and approximately half of children in the US do not achieve minimum recommendations for physical activity (US Department of Health and Human Services, 2008), resulting in high rates of overweight and obesity and over 14 billion dollars in annual health care expenditures (Cawley & Meyerhoefer, 2012). Recent

research has focused on the effects of the social and built environments of neighborhoods on PA (Bauman et al., 2012; Ding et al., 2011; Sallis et al., 2011), but pathways to PA are still unclear. This study investigated the role of a comprehensive assessment of mothers' perceived neighborhood safety (PNS) on children's and mothers' PA using data from the GROW study of California mothers.

In this study a confirmatory factor analysis found that a multi-dimensional assessment of PNS, consisting of mothers' assessments of safety from crime, social cohesion, general safety and traffic safety, was well supported by the GROW data. In a structural equation model this measure of PNS partially mediated the effects of household SEP on children's PA and fully mediated the influence of park availability and safety. This analysis also demonstrated no direct or indirect relationship from neighborhood SEP to children's PA. While PNS was important to children's PA, it was not related to mothers' PA. In an exploratory phase of analysis one aspect of PNS, social cohesion, was found to be significantly related to mothers' PA and partially mediated relationships from perceived crime, household SEP and neighborhood SEP to mothers' PA. Social cohesion also fully mediated the relationship from park availability/safety to PA. Social cohesion similarly mediated relationships to children's PA.

Understanding of these relationships could perhaps be improved upon in future research including additional variables, such as objective assessments of the built environment and other recreational facilities, and other indicators of individual health such as body mass index and nutrition information. These findings support the use of neighborhood-level interventions to improve social cohesion and reduce actual and

perceived crime. These intervention efforts should perhaps focus on families with lower household SEP, which is inversely associated with PA for both children and mothers.

Overweight and obesity are serious health conditions that can be life-limiting, but they are preventable through healthy eating and engagement in PA. It is absolutely imperative to continue public health research and interventions across ecological levels to curb the epidemic of overweight and obesity.

References

Abdullah, A., Wolfe, R., Stoelwinder, J. U., de Courten, M., Stevenson, C., Walls, H. L., & Peeters, A. (2011). The number of years lived with obesity and the risk of all-cause and cause-specific mortality. *International journal of epidemiology, 40*(4), 985-996. doi: 10.1093/ije/dyr018

Ali, M. K., Bullard, K. M., Beckles, G. L., Stevens, M. R., Barker, L., Narayan, K. V., & Imperatore, G. (2011). Household Income and Cardiovascular Disease Risks in US Children and Young Adults Analyses from NHANES 1999–2008. *Diabetes Care, 34*(9), 1998-2004.

Allegrante, J. P., Marks, R., & Hanson, D. W. (2006). Ecological models for the prevention and control of injury. In A. C. Gielen, D. A. Sleet & R. Di Clemente (Eds.), *Injury and Violence Prevention: Behavioral Science Theories, Methods and Applications* (pp. 105-126). San Francisco: Jossey-Bass.

Allender, S., Hutchinson, L., & Foster, C. (2008). Life-change events and participation in physical activity: a systematic review. *Health Promotion International, 23*(2), 160-172.

Aryana, M., Li, Z., & Bommer, W. J. (2012). Obesity and physical fitness in California school children. *American heart journal, 163*(2), 302-312.

Athukorala, C., Rumbold, A. R., Willson, K. J., & Crowther, C. A. (2010). The risk of adverse pregnancy outcomes in women who are overweight or obese. *BMC pregnancy and childbirth, 10*(1), 56.

Austin, D. M., Furr, L. A., & Spine, M. (2002). The effects of neighborhood conditions on perceptions of safety. *Journal of Criminal Justice, 30*(5), 417-427. doi: http://dx.doi.org/10.1016/S0047-2352(02)00148-4

Baba, Y., & Austin, D. M. (1989). Neighborhood environmental satisfaction, victimization, and social participation as determinants of perceived neighborhood safety. *Environment and Behavior, 21*(6), 763-780.

Babey, S. H., Hastert, T. A., Yu, H., & Brown, E. R. (2008). Physical Activity Among Adolescents: When Do Parks Matter? *American journal of preventive medicine, 34*(4), 345-348. doi: http://dx.doi.org/10.1016/j.amepre.2008.01.020

Babey, S. H., Wolstein, J., Diamant, A. L., Bloom, A., & Goldstein, H. (2011). A Patchwork of Progress: Changes in Overweight and Obesity Among California 5th, 7th, and 9th Graders, 2005-2010.

Bacha, J. M., Appugliese, D., Coleman, S., Kaciroti, N., Bradley, R. H., Corwyn, R. F., & Lumeng, J. C. (2010). Maternal perception of neighborhood safety as a predictor of child weight status: The moderating effect of gender and assessment of potential mediators. *International Journal of Pediatric Obesity, 5*(1), 72-79.

Bandura, A. (2001). Social cognitive theory: An agentic perspective. *Annual review of psychology, 52*(1), 1-26.

Baum, F. E., Ziersch, A. M., Zhang, G., & Osborne, K. (2009). Do perceived neighbourhood cohesion and safety contribute to neighbourhood differences in health? *Health & Place, 15*(4), 925-934. doi: http://dx.doi.org/10.1016/j.healthplace.2009.02.013

Bauman, A. E., Reis, R. S., Sallis, J. F., Wells, J. C., Loos, R. J. F., & Martin, B. W. (2012). Correlates of physical activity: why are some people physically active and others not? *The lancet, 380*(9838), 258-271. doi: http://dx.doi.org/10.1016/S0140-6736(12)60735-1

Bedimo-Rung, A. L., Mowen, A. J., & Cohen, D. A. (2005). The significance of parks to physical activity and public health: A conceptual model. *American journal of preventive medicine, 28*(2, Supplement 2), 159-168. doi: http://dx.doi.org/10.1016/j.amepre.2004.10.024

Beets, M. W., & Foley, J. T. (2008). Association of Father Involvement and Neighborhood Quality with Kindergartners' Physical Activity: A Multilevel Structural Equation Model. *American Journal of Health Promotion, 22*(3), 195-203.

Bellows-Riecken, K. H., & Rhodes, R. E. (2008). A birth of inactivity? A review of physical activity and parenthood. *Preventive Medicine, 46*(2), 99-110. doi: http://dx.doi.org/10.1016/j.ypmed.2007.08.003

Bennett, G. G., McNeill, L. H., Wolin, K. Y., Duncan, D. T., Puleo, E., & Emmons, K. M. (2007). Safe to walk? Neighborhood safety and physical activity among public housing residents. *PLoS medicine, 4*(10), e306.

Beydoun, M. A., & Wang, Y. (2009). Pathways linking socioeconomic status to obesity through depression and lifestyle factors among young US adults. *Journal of Affective Disorders, 123*(1), 52-63. doi: 10.1016/j.jad.2009.09.021

Biddle, S. J., Whitehead, S. H., O'Donovan, T. M., & Nevill, M. E. (2005). Correlates of Participation in Physical Activity for Adolescent Girls: A Systematic Review of Recent Literature. *Journal of Physical Activity & Health, 2*(4).

Blanchard, C. M., McGannon, K. R., Spence, J. C., Rhodes, R. E., Nehl, E., Baker, F., & Bostwick, J. (2005). Social ecological correlates of physical activity in normal weight, overweight, and obese individuals. *International journal of obesity, 29*(6), 720-726.

Boney, C. M., Verma, A., Tucker, R., & Vohr, B. R. (2005). Metabolic syndrome in childhood: association with birth weight, maternal obesity, and gestational diabetes mellitus. *Pediatrics, 115*(3), e290-e296.

Braveman, P., Cubbin, C., Egerter, S., Chideya, S., Marchi, K. S., Metzler, M., & Posner, S. (2005). Socioeconomic status in health research. *JAMA: the journal of the American Medical Association, 294*(22), 2879-2888.

Braveman, P., Cubbin, C., Egerter, S., Williams, D. R., & Pamuk, E. (2010). Socioeconomic disparities in health in the United States: what the patterns tell us. *Journal Information, 100*(S1).

Braveman, P., Cubbin, C., Marchi, K., Egerter, S., & Chavez, G. (2001). Measuring socioeconomic status/position in studies of racial/ethnic disparities: maternal and infant health. *Public health reports, 116*(5), 449.

Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design*: Harvard University Press.

Bronfenbrenner, U. (1986). Ecology of the family as a context for human development: Research perspectives. *Developmental psychology, 22*(6), 723.

Brown, B. B., Perkins, D. D., & Brown, G. (2004). Incivilities, place attachment and crime: Block and individual effects. *Journal of Environmental Psychology, 24*(3), 359-371. doi: http://dx.doi.org/10.1016/j.jenvp.2004.01.001

Brownson, R. C., Baker, E. A., Housemann, R. A., Brennan, L. K., & Bacak, S. J. (2001). Environmental and policy determinants of physical activity in the United States. *American journal of public health, 91*(12), 1995-2003.

Burdette, H. L., & Whitaker, R. C. (2004). Neighborhood playgrounds, fast food restaurants, and crime: relationships to overweight in low-income preschool children. *Preventive Medicine, 38*(1), 57-63. doi: http://dx.doi.org/10.1016/j.ypmed.2003.09.029

Burdette, H. L., & Whitaker, R. C. (2005). A national study of neighborhood safety, outdoor play, television viewing, and obesity in preschool children. *Pediatrics, 116*(3), 657-662.

Byrne, B. M. (2000). *Structural Equation Modeling with AMOS : Basic Concepts, Applications, and Programming*. Mahwah, N.J.: Lawrence Erlbaum Associates.

Cagney, K. A., Browning, C. R., & Wen, M. (2005). Racial disparities in self-rated health at older ages: What difference does the neighborhood make? *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 60*(4), S181-S190.

Carver, A., Salmon, J., Campbell, K., Baur, L., Garnett, S., & Crawford, D. (2005). How do perceptions of local neighborhood relate to adolescents' walking and cycling? *American Journal of Health Promotion, 20*(2), 139-147.

Carver, A., Timperio, A., & Crawford, D. (2008). Playing it safe: The influence of neighbourhood safety on children's physical activity—A review. *Health & Place, 14*(2), 217-227. doi: http://dx.doi.org/10.1016/j.healthplace.2007.06.004

Carver, A., Timperio, A., Hesketh, K., & Crawford, D. (2010). Are children and adolescents less active if parents restrict their physical activity and active transport due to perceived risk? *Social science & medicine, 70*(11), 1799-1805. doi: http://dx.doi.org/10.1016/j.socscimed.2010.02.010

Cawley, J. (2010). The economics of childhood obesity. *Health Affairs, 29*(3), 364-371.

Cawley, J., & Meyerhoefer, C. (2012). The medical care costs of obesity: an instrumental variables approach. *Journal of health economics, 31*(1), 219-230.

Centers for Disease Control. (2011, November 9, 2011). Physical Activity Guidelines for Americans. Retrieved February 14, 2014, from http://www.cdc.gov/physicalactivity/everyone/guidelines/children

Centers for Disease Control. (2013, July 10, 2013). Childhood Obesity Facts. Retrieved January 28 2013, from http://www.cdc.gov/healthyyouth/obesity/facts.htm

Centers for Disease Control and Prevention. (2010). The association between school based physical activity, including physical education, and academic performance. *Atlanta, GA: US Department of Health and Human Services*.

Centers for Disease Control and Prevention. (2014a). Adult Obesity Facts. Retrieved June 7, 2014, from http://www.cdc.gov/obesity/data/adult

Centers for Disease Control and Prevention. (2014b). Youth Online: Youth Risk Behavior Surveillance System 1991-2011. Retrieved June 6, 2014, from http://apps.nccd.cdc.gov/youthonline

Cohen, D. A., Ashwood, J. S., Scott, M. M., Overton, A., Evenson, K. R., Staten, L. K., . . . Catellier, D. (2006). Public parks and physical activity among adolescent girls. *Pediatrics, 118*(5), e1381-e1389.

Control, C. f. D., & Prevention. (2003). Physical activity levels among children aged 9-13 years--United States, 2002. *MMWR. Morbidity and mortality weekly report, 52*(33), 785.

Cradock, A. L., Kawachi, I., Colditz, G. A., Gortmaker, S. L., & Buka, S. L. (2009). Neighborhood social cohesion and youth participation in physical activity in Chicago. *Social science & medicine, 68*(3), 427-435. doi: http://dx.doi.org/10.1016/j.socscimed.2008.10.028

Craggs, C., Corder, K., van Sluijs, E. M., & Griffin, S. J. (2011). Determinants of change in physical activity in children and adolescents: a systematic review. *American journal of preventive medicine, 40*(6), 645-658.

Cubbin, C., & Smith, G. S. (2002). Socioeconomic Inequaities in Injury: Critical Issues in Design and Analysis. *Annual review of public health, 23*(1), 349-375. doi: 10.1146/annurev.publhealth.23.100901.140548

Curtis, L. J., Dooley, M. D., & Phipps, S. A. (2004). Child well-being and neighbourhood quality: evidence from the Canadian National Longitudinal Survey of Children and Youth. *Social science & medicine, 58*(10), 1917-1927.

Daniels, S. R., Arnett, D. K., Eckel, R. H., Gidding, S. S., Hayman, L. L., Kumanyika, S., . . . Williams, C. L. (2005). Overweight in children and adolescents pathophysiology, consequences, prevention, and treatment. *Circulation, 111*(15), 1999-2012.

Datar, A., Nicosia, N., & Shier, V. (2013). Parent Perceptions of Neighborhood Safety and Children's Physical Activity, Sedentary Behavior, and Obesity: Evidence from a National Longitudinal Study. *American journal of epidemiology*. doi: 10.1093/aje/kws353

Davison, K. K., & Lawson, C. T. (2006). Do attributes in the physical environment influence children's physical activity? A review of the literature. *International Journal of Behavioral Nutrition and Physical Activity, 3*(1), 19.

De Jesus, M., Puleo, E., Shelton, R. C., & Emmons, K. M. (2010). Associations between perceived social environment and neighborhood safety: Health implications. *Health & Place, 16*(5), 1007-1013. doi: http://dx.doi.org/10.1016/j.healthplace.2010.06.005

DeFrancesco, S., Bishai, D., Mahoney, P., Ho, S., & Guyer, B. (2004). Child pedestrians: the role of parental beliefs and practices in promoting safe walking in urban neighborhoods. *Journal of Urban Health, 81*(4), 545-555.

Devlin, M. J., Yanovski, S. Z., & Wilson, G. T. (2000). Obesity: what mental health professionals need to know. *American Journal of Psychiatry, 157*(6), 854-866.

Dietz, W. H. (1998). Health consequences of obesity in youth: childhood predictors of adult disease. *Pediatrics, 101*(Supplement 2), 518-525.

Diez Roux, A. V., & Mair, C. (2010). Neighborhoods and health. *Annals of the New York Academy of Sciences, 1186*(1), 125-145.

Ding, D., Sallis, J. F., Kerr, J., Lee, S., & Rosenberg, D. E. (2011). Neighborhood environment and physical activity among youth: a review. *American journal of preventive medicine, 41*(4), 442-455.

Dowda, M., Ainsworth, B. E., Addy, C. L., Saunders, R., & Riner, W. (2003). Correlates of physical activity among US young adults, 18 to 30 years of age, from NHANES III. *Annals of Behavioral Medicine, 26*(1), 15-23.

Eaton, D. K., Kann, L., Kinchen, S., Shanklin, S., Flint, K. H., Hawkins, J., . . . Chyen, D. (2012). Youth Risk Behavior Surveillance--United States, 2011. Morbidity and Mortality Weekly Report. Surveillance Summaries. Volume 61, Number 4. *Centers for Disease Control and Prevention*.

Ebbeling, C. B., Pawlak, D. B., & Ludwig, D. S. (2002). Childhood obesity: public-health crisis, common sense cure. *The lancet, 360*(9331), 473-482.

Economos, C. D., Hyatt, R. R., Goldberg, J. P., Must, A., Naumova, E. N., Collins, J. J., & Nelson, M. E. (2007). A Community Intervention Reduces BMI z-score in Children: Shape Up Somerville First Year Results. *Obesity, 15*(5), 1325-1336.

Edwardson, C. L., & Gorely, T. (2010). Parental influences on different types and intensities of physical activity in youth: A systematic review. *Psychology of Sport and Exercise, 11*(6), 522-535. doi: http://dx.doi.org/10.1016/j.psychsport.2010.05.001

Ellen, I. G., Mijanovich, T., & Dillman, K. N. (2001). Neighborhood effects on health: exploring the links and assessing the evidence. *Journal of Urban Affairs, 23*(3-4), 391-408.

Enders, C. K., & Bandalos, D. L. (2001). The relative performance of full information maximum likelihood estimation for missing data in structural equation models. *Structural Equation Modeling, 8*(3), 430-457.

Eyler, A., Brownson, R. C., Donatelle, R. J., King, A. C., Brown, D., & Sallis, J. F. (1999). Physical activity social support and middle-and older-aged minority women: results from a US survey. *Social science & medicine*, *49*(6), 781-789.

Eyler, A., Wilcox, S., Matson-Koffman, D., Evenson, K. R., Sanderson, B., Thompson, J., . . . Rohm-Young, D. (2002). Correlates of physical activity among women from diverse racial/ethnic groups. *Journal of women's health & gender-based medicine*, *11*(3), 239-253.

Ferraro, K. F., & LaGrange, R. L. (1992). Are older people most afraid of crime? Reconsidering age differences in fear of victimization. *Journal of Gerontology*, *47*(5), S233-S244.

Ferreira, I., Van Der Horst, K., Wendel-Vos, W., Kremers, S., Van Lenthe, F. J., & Brug, J. (2007). Environmental correlates of physical activity in youth – a review and update. *Obesity Reviews*, *8*(2), 129-154. doi: 10.1111/j.1467-789X.2006.00264.x

Flegal, K. M., Carroll, M. D., Kit, B. K., & Ogden, C. L. (2012). Prevalence of obesity and trends in the distribution of body mass index among US adults, 1999-2010. *Jama*, *307*(5), 491-497.

Floyd, M. F., Spengler, J. O., Maddock, J. E., Gobster, P. H., & Suau, L. J. (2008). Park-based physical activity in diverse communities of two US cities: an observational study. *American journal of preventive medicine*, *34*(4), 299-305.

Foster, S., & Giles-Corti, B. (2008). The built environment, neighborhood crime and constrained physical activity: An exploration of inconsistent findings. *Preventive Medicine*, *47*(3), 241-251. doi: http://dx.doi.org/10.1016/j.ypmed.2008.03.017

Franzini, L., Caughy, M., Spears, W., & Fernandez Esquer, M. (2005). Neighborhood economic conditions, social processes, and self-rated health in low-income neighborhoods in Texas: A multilevel latent variables model. *Social science & medicine*, *61*(6), 1135-1150.

Franzini, L., Caughy, M. O. B., Nettles, S. M., & O'Campo, P. (2008). Perceptions of disorder: Contributions of neighborhood characteristics to subjective perceptions of disorder. *Journal of Environmental Psychology*, *28*(1), 83-93. doi: http://dx.doi.org/10.1016/j.jenvp.2007.08.003

Franzini, L., Elliott, M. N., Cuccaro, P., Schuster, M., Gilliland, M. J., Grunbaum, J. A., . . . Tortolero, S. R. (2009). Influences of physical and social neighborhood environments on children's physical activity and obesity. *American journal of public health*, *99*(2), 271-278.

French, S. A., Story, M., & Jeffery, R. W. (2001). Environmental influences on eating and physical activity. *Annual review of public health, 22*(1), 309-335.

Fritz, M. S., & MacKinnon, D. P. (2007). Required sample size to detect the mediated effect. *Psychological science, 18*(3), 233-239.

Geiser, C. (2012). *Data Analysis with Mplus* New York, London: The Guilford Press.

Giles-Corti, B., & Donovan, R. (2002a). The relative influence of individual, social and physical environment determinants of physical activity. *Social science & medicine, 54*(12), 1793-1812.

Giles-Corti, B., & Donovan, R. (2002b). Socioeconomic Status Differences in Recreational Physical Activity Levels and Real and Perceived Access to a Supportive Physical Environment. *Preventive Medicine, 35*(6), 601-611. doi: http://dx.doi.org/10.1006/pmed.2002.1115

Gómez, J. E., Johnson, B. A., Selva, M., & Sallis, J. F. (2004). Violent crime and outdoor physical activity among inner-city youth. *Preventive Medicine, 39*(5), 876-881. doi: http://dx.doi.org/10.1016/j.ypmed.2004.03.019

Gordon-Larsen, P., Nelson, M. C., Page, P., & Popkin, B. M. (2006). Inequality in the built environment underlies key health disparities in physical activity and obesity. *Pediatrics, 117*(2), 417-424.

Greves Grow, H. M., Cook, A. J., Arterburn, D. E., Saelens, B. E., Drewnowski, A., & Lozano, P. (2010). Child obesity associated with social disadvantage of children's neighborhoods. *Social science & medicine, 71*(3), 584-591. doi: http://dx.doi.org/10.1016/j.socscimed.2010.04.018

Hicks, S., & Brown, S. (2013). Perceptions of risk: A review of the effects of individual and community-level variables on perceptions of risk. *International Review of Victimology, 19*(3), 249-267. doi: 10.1177/0269758013492753

Hill, N. E., & Herman-Stahl, M. A. (2002). Neighborhood safety and social involvement: Associations with parenting behaviors and depressive symptoms among African-American and Euro-American mothers. *Journal of Family Psychology, 16*(2), 209.

Hinkley, T., Crawford, D., Salmon, J., Okely, A. D., & Hesketh, K. (2008). Preschool Children and Physical Activity: A Review of Correlates. *American journal of preventive medicine, 34*(5), 435-441.e437. doi: http://dx.doi.org/10.1016/j.amepre.2008.02.001

Hu, L. t., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal, 6*(1), 1-55.

Humpel, N., Owen, N., & Leslie, E. (2002). Environmental factors associated with adults' participation in physical activity: a review. *American journal of preventive medicine, 22*(3), 188-199.

Jencks, C., & Mayer, S. E. (1990). The social consequences of growing up in a poor neighborhood. *Inner-city poverty in the United States, 111*.

Johnson, S. L., Solomon, B. S., Shields, W. C., McDonald, E. M., McKenzie, L. B., & Gielen, A. C. (2009). Neighborhood violence and its association with mothers' health: assessing the relative importance of perceived safety and exposure to violence. *Journal of Urban Health, 86*(4), 538-550.

Kaczynski, A. T., Potwarka, L. R., & Saelens, B. E. (2008). Association of park size, distance, and features with physical activity in neighborhood parks. *American journal of public health, 98*(8), 1451.

Kaewthummanukul, T., & Brown, K. C. (2006). Determinants of employee participation in physical activity: critical review of the literature. *AAOHN journal: official journal of the American Association of Occupational Health Nurses, 54*(6), 249-261.

Kawachi, I., & Berkman, L. (2000). Social cohesion, social capital, and health. *Social epidemiology*, 174-190.

Kawachi, I., & Berkman, L. F. (2003). Neighborhoods and health.

Kawachi, I., Kennedy, B. P., & Wilkinson, R. G. (1999). Crime: social disorganization and relative deprivation. *Social science & medicine, 48*(6), 719-731.

Kiernan, M., Schoffman, D., Lee, K., Brown, S., Fair, J., Perri, M., & Haskell, W. (2013). The Stanford Leisure-Time Activity Categorical Item (L-Cat): a single categorical item sensitive to physical activity changes in overweight/obese women. *International journal of obesity, 37*(12), 1597-1602.

King, A. C., Castro, C., Wilcox, S., Eyler, A., Sallis, J. F., & Brownson, R. C. (2000). Personal and environmental factors associated with physical inactivity among different racial–ethnic groups of US middle-aged and older-aged women. *Health psychology, 19*(4), 354.

Kline, R. B. (2011). *Principles and practice of structural equation modeling*: Guilford press.

Kling, J. R., Liebman, J. B., & Katz, L. F. (2007). Experimental analysis of neighborhood effects. *Econometrica, 75*(1), 83-119.

Koebnick, C., Coleman, K. J., Black, M. H., Smith, N., Der-Sarkissian, J. K., Jacobsen, S. J., & Porter, A. H. (2012). Cohort Profile: The KPSC Children's Health Study, a population-based study of 920 000 children and adolescents in southern California. *International journal of epidemiology, 41*(3), 627-633.

Krebs, N. F., Himes, J. H., Jacobson, D., Nicklas, T. A., Guilday, P., & Styne, D. (2007). Assessment of child and adolescent overweight and obesity. *Pediatrics, 120*(Supplement 4), S193-S228.

Krieger, N. (2001). Theories for social epidemiology in the 21st century: an ecosocial perspective. *International journal of epidemiology, 30*(4), 668-677. doi: 10.1093/ije/30.4.668

Kuczmarski, R. J., Ogden, C. L., & Guo, S. S. (2002). CDC growth charts for the United States: Methods and development

National Center for Health Statistics Vital Health Stat

11(246).

Lee, R. E., & Cubbin, C. (2002). Neighborhood context and youth cardiovascular health behaviors. *American journal of public health, 92*(3), 428-436.

Lee, R. E., Cubbin, C., & Winkleby, M. (2007). Contribution of neighbourhood socioeconomic status and physical activity resources to physical activity among women. *Journal of epidemiology and community health, 61*(10), 882-890. doi: 10.1136/jech.2006.054098

Leventhal, T., & Brooks-Gunn, J. (2000). The neighborhoods they live in: the effects of neighborhood residence on child and adolescent outcomes. *Psychological bulletin, 126*(2), 309.

Link, B. G., & Phelan, J. (1995). Social conditions as fundamental causes of disease. *Journal of health and social behavior*, 80-94.

Lumeng, J. C., Appugliese, D., Cabral, H. J., Bradley, R. H., & Zuckerman, B. (2006). Neighborhood safety and overweight status in children. *Archives of Pediatrics & Adolescent Medicine, 160*(1), 25.

Luppino, F. S., de Wit, L. M., Bouvy, P. F., & et al. (2010). Overweight, obesity, and depression: A systematic review and meta-analysis of longitudinal studies. *Archives of General Psychiatry, 67*(3), 220-229. doi: 10.1001/archgenpsychiatry.2010.2

MacCallum, R. C., Browne, M. W., & Sugawara, H. M. (1996). Power analysis and determination of sample size for covariance structure modeling. *Psychological methods, 1*(2), 130.

Macintyre, S., & Ellaway, A. (2003). Neighborhoods and health: an overview. *Neighborhoods and health*, 20-42.

May, A. L., Freedman, D., Sherry, B., & Blanck, H. M. (2013). Obesity - United States, 1999-2010. *MMWR Surveill Summ, 62 Suppl 3*, 120-128.

McLeroy, K. R., & et al. (1988). An Ecological Perspective on Health Promotion Programs. *Health Education Quarterly, 15*(4), 351-377.

McNeill, L. H., Kreuter, M. W., & Subramanian, S. (2006a). Social environment and physical activity: a review of concepts and evidence. *Social science & medicine, 63*(4), 1011-1022.

McNeill, L. H., Kreuter, M. W., & Subramanian, S. V. (2006b). Social Environment and Physical activity: A review of concepts and evidence. *Social science & medicine, 63*(4), 1011-1022. doi: http://dx.doi.org/10.1016/j.socscimed.2006.03.012

Meredith, W., & Teresi, J. A. (2006). An essay on measurement and factorial invariance. *Medical care, 44*(11), S69-S77.

Miles, R. (2008). Neighborhood Disorder, Perceived Safety, and Readiness to Encourage Use of Local Playgrounds. *American journal of preventive medicine, 34*(4), 275-281. doi: http://dx.doi.org/10.1016/j.amepre.2008.01.007

Molnar, B. E., Gortmaker, S. L., Bull, F. C., & Buka, S. L. (2004). Unsafe to play? Neighborhood disorder and lack of safety predict reduced physical activity among urban children and adolescents. *American Journal of Health Promotion, 18*(5), 378-386.

Motl, R. W., Birnbaum, A. S., Kubik, M. Y., & Dishman, R. K. (2004). Naturally occurring changes in physical activity are inversely related to depressive symptoms during early adolescence. *Psychosomatic Medicine, 66*(3), 336-342.

Must, A., Spadano, J., Coakley, E. H., Field, A. E., Colditz, G., & Dietz, W. H. (1999). The disease burden associated with overweight and obesity. *Jama, 282*(16), 1523-1529.

Muthén, L., & Muthén, B. (2012). Mplus User's Guide (7th ed.). Los Angeles, CA: Muthen & Muthen.

National Institutes of Health. (1998). *Clinical Guidelines on the Identification, Evaluation and Treatment of Overweight and Obesity in Adults: the Evidence Report*. Retrieved from http://www.nhlbi.nih.gov/guidelines/obesity/ob_gdlns.pdf.

Ogden, C. L. (2010). *Obesity and socioeconomic status in adults: United States, 2005-2008*: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics.

Ogden, C. L., Carroll, M. D., Kit, B. K., & Flegal, K. M. (2012). Prevalence of obesity and trends in body mass index among US children and adolescents, 1999-2010. *JAMA: the journal of the American Medical Association, 307*(5), 483-490.

Ogden, C. L., Carroll, M. D., Kit, B. K., & Flegal, K. M. (2014). Prevalence of childhood and adult obesity in the united states, 2011-2012. *Jama, 311*(8), 806-814. doi: 10.1001/jama.2014.732

Pebley, A. R., & Sastry, N. (2004). Neighborhoods, poverty, and children's well-being. *Social inequality*, 119-145.

Perkins, D. D., Meeks, J. W., & Taylor, R. B. (1992). The physical environment of street blocks and resident perceptions of crime and disorder: implications for theory and measurement. *Journal of Environmental Psychology, 12*(1), 21-34. doi: http://dx.doi.org/10.1016/S0272-4944(05)80294-4

Perkins, D. D., & Taylor, R. B. (2002). Ecological assessments of community disorder: Their relationship to fear of crime and theoretical implications *Ecological Research to Promote Social Change* (pp. 127-170): Springer.

Physical Activity Guidelines Advisory Committee. (2008). Physical activity guidelines advisory committee report, 2008. *Washington, DC: US Department of Health and Human Services, 2008*, A1-H14.

Pi-Sunyer, F. X. (1993). Medical hazards of obesity. *Annals of internal medicine, 119*(7_Part_2), 655-660.

Pickett, K. E., & Pearl, M. (2001). Multilevel analyses of neighbourhood socioeconomic context and health outcomes: a critical review. *Journal of epidemiology and community health, 55*(2), 111-122.

Pinderhughes, E. E., Nix, R., Foster, E. M., & Jones, D. (2001). Parenting in context: Impact of neighborhood poverty, residential stability, public services, social networks, and danger on parental behaviors. *Journal of Marriage and Family, 63*(4), 941-953.

Pitner, R., Yu, M., & Brown, E. (2012). Making neighborhoods safer: Examining predictors of residents' concerns about neighborhood safety. *Journal of Environmental Psychology, 32*(1), 43-49. doi: http://dx.doi.org/10.1016/j.jenvp.2011.09.003

Powell, L. M., Slater, S., Chaloupka, F. J., & Harper, D. (2006). Availability of Physical Activity–Related Facilities and Neighborhood Demographic and Socioeconomic Characteristics: A National Study. *American journal of public health, 96*(9), 1676-1680. doi: 10.2105/AJPH.2005.065573

Prince, S. A., Adamo, K. B., Hamel, M. E., Hardt, J., Gorber, S. C., & Tremblay, M. (2008). A comparison of direct versus self-report measures for assessing physical activity in adults: a systematic review. *International Journal of Behavioral Nutrition and Physical Activity, 5*(1), 56.

Reilly, J. J., Methven, E., McDowell, Z. C., Hacking, B., Alexander, D., Stewart, L., & Kelnar, C. J. (2003). Health consequences of obesity. *Archives of disease in childhood, 88*(9), 748-752.

Reilly, J. J., Penpraze, V., Hislop, J., Davies, G., Grant, S., & Paton, J. Y. (2008). Objective measurement of physical activity and sedentary behaviour: review with new data. *Archives of disease in childhood, 93*(7), 614-619.

Roman, C. G., & Chalfin, A. (2008). Fear of walking outdoors: a multilevel ecologic analysis of crime and disorder. *American journal of preventive medicine, 34*(4), 306-312.

Ross, C. E., & Jang, S. J. (2000). Neighborhood disorder, fear, and mistrust: The buffering role of social ties with neighbors. *American journal of community psychology, 28*(4), 401-420.

Roux, A. V. D., Evenson, K. R., McGinn, A. P., Brown, D. G., Moore, L., Brines, S., & Jacobs Jr, D. R. (2007). Availability of recreational resources and physical activity in adults. *Journal Information, 97*(3).

Rundmo, T. (1996). Associations between risk perception and safety. *Safety Science, 24*(3), 197-209. doi: http://dx.doi.org/10.1016/S0925-7535(97)00038-6

Saelens, B. E., Sallis, J. F., Black, J. B., & Chen, D. (2003). Neighborhood-based differences in physical activity: an environment scale evaluation. *American journal of public health, 93*(9), 1552-1558.

Saelens, B. E., Sallis, J. F., Frank, L. D., Couch, S. C., Zhou, C., Colburn, T., . . . Glanz, K. (2012). Obesogenic neighborhood environments, child and parent obesity: the

Neighborhood Impact on Kids study. *American journal of preventive medicine, 42*(5), e57-e64.

Sallis, J. F., Floyd, M. F., Rodríguez, D. A., & Saelens, B. E. (2012). Role of built environments in physical activity, obesity, and cardiovascular disease. *Circulation, 125*(5), 729-737.

Sallis, J. F., & Glanz, K. (2006). The role of built environments in physical activity, eating, and obesity in childhood. *The future of children, 16*(1), 89-108.

Sallis, J. F., Johnson, M. F., Calfas, K. J., Caparosa, S., & Nichols, J. F. (1997). Assessing perceived physical environmental variables that may influence physical activity. *Research quarterly for exercise and sport, 68*(4), 345-351.

Sallis, J. F., Prochaska, J. J., & Taylor, W. C. (2000). A review of correlates of physical activity of children and adolescents. *Medicine and science in sports and exercise, 32*(5), 963-975.

Sallis, J. F., Slymen, D. J., Conway, T. L., Frank, L. D., Saelens, B. E., Cain, K., & Chapman, J. E. (2011). Income disparities in perceived neighborhood built and social environment attributes. *Health & Place, 17*(6), 1274-1283.

Sampson, R. J., & Groves, W. B. (1989). Community structure and crime: Testing social-disorganization theory. *American Journal of Sociology*, 774-802.

Sampson, R. J., Morenoff, J. D., & Earls, F. (1999). Beyond social capital: Spatial dynamics of collective efficacy for children. *American sociological review*, 633-660.

Sampson, R. J., Morenoff, J. D., & Felton, E. (1999). Beyond Social Capital: Spatial Dynamics of Collective Efficacy for Children. *American Sociological Review, 64*(5), 633-660. doi: 10.2307/2657367

Sampson, R. J., Morenoff, J. D., & Gannon-Rowley, T. (2002). Assessing" neighborhood effects": Social processes and new directions in research. *Annual Review of Sociology*, 443-478.

Sampson, R. J., & Raudenbush, S. W. (2004). Seeing disorder: Neighborhood stigma and the social construction of "broken windows". *Social psychology quarterly, 67*(4), 319-342.

Sampson, R. J., Raudenbush, S. W., & Earls, F. (1997). Neighborhoods and violent crime: A multilevel study of collective efficacy. *Science, 277*(5328), 918-924.

Scarborough, B. K., Like-Haislip, T. Z., Novak, K. J., Lucas, W. L., & Alarid, L. F. (2010). Assessing the relationship between individual characteristics, neighborhood context, and fear of crime. *Journal of Criminal Justice, 38*(4), 819-826. doi: http://dx.doi.org/10.1016/j.jcrimjus.2010.05.010

Schreiber, J. B., Nora, A., Stage, F. K., Barlow, E. A., & King, J. (2006). Reporting structural equation modeling and confirmatory factor analysis results: A review. *The Journal of Educational Research, 99*(6), 323-338.

Schulz, A., & Northridge, M. E. (2004). Social determinants of health: implications for environmental health promotion. *Health Education & Behavior, 31*(4), 455-471.

Schulz, A. J., Kannan, S., Dvonch, J. T., Israel, B. A., Allen III, A., James, S. A., . . . Lepkowski, J. (2005). Social and physical environments and disparities in risk for cardiovascular disease: the healthy environments partnership conceptual model. *Environmental health perspectives*, 1817-1825.

Schwimmer, J. B., Burwinkle, T. M., & Varni, J. W. (2003). Health-related quality of life of severely obese children and adolescents. *JAMA: the journal of the American Medical Association, 289*(14), 1813-1819.

Shoemaker, D. J. (2010). Social Disorganization and Anomie *Theories of delinquency : an examination of explanations of delinquent behavior*

(6th ed.). New York: Oxford University Press.

Simon, G. E., Ludman, E. J., Linde, J. A., Operskalski, B. H., Ichikawa, L., Rohde, P., . . . Jeffery, R. W. (2008). Association between obesity and depression in middle-aged women. *General hospital psychiatry, 30*(1), 32-39.

Singh, G. K., Kogan, M. D., & van Dyck, P. C. (2008). A multilevel analysis of state and regional disparities in childhood and adolescent obesity in the United States. *Journal of community health, 33*(2), 90-102.

Steptoe, A., & Feldman, P. J. (2001). Neighborhood problems as sources of chronic stress: development of a measure of neighborhood problems, and associations with socioeconomic status and health. *Annals of Behavioral Medicine, 23*(3), 177-185.

Sternfeld, B., Ainsworth, B. E., & Quesenberry Jr, C. (1999). Physical activity patterns in a diverse population of women. *Preventive Medicine, 28*(3), 313-323.

Stimpson, J. P., Ju, H., Raji, M. A., & Eschbach, K. (2007). Neighborhood Deprivation and Health Risk Behaviors in NHANES III. *American Journal of Health Behavior, 31*(2), 215-222. doi: 10.5993/AJHB.31.2.10

Ströhle, A. (2009). Physical activity, exercise, depression and anxiety disorders. *Journal of neural transmission, 116*(6), 777-784.

Strong, W. B., Malina, R. M., Blimkie, C. J. R., Daniels, S. R., Dishman, R. K., Gutin, B., . . . Trudeau, F. (2005). Evidence Based Physical Activity for School-age Youth. *The Journal of Pediatrics, 146*(6), 732-737. doi: http://dx.doi.org/10.1016/j.jpeds.2005.01.055

Timperio, A., Crawford, D., Telford, A., & Salmon, J. (2004). Perceptions about the local neighborhood and walking and cycling among children. *Preventive Medicine, 38*(1), 39-47.

Troiano, R. P., Berrigan, D., Dodd, K. W., Mâsse, L. C., Tilert, T., & McDowell, M. (2008). Physical activity in the United States measured by accelerometer. *Medicine and science in sports and exercise, 40*(1), 181.

Trost, S. G., Owen, N., Bauman, A. E., Sallis, J. F., & Brown, W. (2002). Correlates of adults' participation in physical activity: review and update. *Medicine & Science in Sports & Exercise*.

Tucker, J. M., Welk, G. J., & Beyler, N. K. (2011). Physical activity in US adults: compliance with the physical activity guidelines for Americans. *American journal of preventive medicine, 40*(4), 454-461.

Ullman, J. B. (2006). Structural equation modeling: Reviewing the basics and moving forward. *Journal of Personality Assessment, 87*(1), 35-50.

US Department of Health and Human Services. (2008). *Physical Activity Guidelines for Americans* Retrieved from http://www.health.gov/paguidelines/

US Department of Health and Human Services. (2013, August 28, 2013). Healthy People 2020, Topics & Objectives: Physical Activity. Retrieved January 28, 2014, from http://www.healthypeople.gov/2020/topicsobjectives2020/objectiveslist

Van der Horst, K., Paw, M., Twisk, J. W., & Van Mechelen, W. (2007). A brief review on correlates of physical activity and sedentariness in youth. *Medicine and science in sports and exercise, 39*(8), 1241.

van Jaarsveld, C. H., Miles, A., & Wardle, J. (2007). Pathways from deprivation to health differed between individual and neighborhood-based indices. *Journal of clinical epidemiology, 60*(7), 712-719.

Vivier, P., & Tompkins, C. (2009). Health consequences of obesity in children and adolescents *Handbook of childhood and adolescent obesity* (pp. 11-24): Springer.

Wall, M. I., Carlson, S. A., Stein, A. D., Lee, S. M., & Fulton, J. E. (2011). Trends by age in youth physical activity: Youth Media Campaign Longitudinal Survey. *Medicine and science in sports and exercise, 43*(11), 2140-2147.

Weden, M. M., Carpiano, R. M., & Robert, S. A. (2008). Subjective and objective neighborhood characteristics and adult health. *Social science & medicine, 66*(6), 1256-1270. doi: http://dx.doi.org/10.1016/j.socscimed.2007.11.041

Weir, L. A., Etelson, D., & Brand, D. A. (2006). Parents' perceptions of neighborhood safety and children's physical activity. *Preventive Medicine, 43*(3), 212-217. doi: http://dx.doi.org/10.1016/j.ypmed.2006.03.024

Wen, M., Hawkley, L. C., & Cacioppo, J. T. (2006). Objective and perceived neighborhood environment, individual SES and psychosocial factors, and self-rated health: An analysis of older adults in Cook County, Illinois. *Social science & medicine, 63*(10), 2575-2590.

Wen, M., Kandula, N. R., & Lauderdale, D. S. (2007). Walking for transportation or leisure: what difference does the neighborhood make? *Journal of general internal medicine, 22*(12), 1674-1680.

Whitaker, R. C., Wright, J. A., Pepe, M. S., Seidel, K. D., & Dietz, W. H. (1997). Predicting obesity in young adulthood from childhood and parental obesity. *New England Journal of Medicine, 337*(13), 869-873.

Williams, D. R., & Jackson, P. B. (2005). Social sources of racial disparities in health. *Health Affairs, 24*(2), 325-334.

Winkleby, M., & Cubbin, C. (2003). Influence of individual and neighbourhood socioeconomic status on mortality among black, Mexican-American, and white women and men in the United States. *Journal of epidemiology and community health, 57*(6), 444-452.

Winkleby, M., Cubbin, C., & Ahn, D. (2006). Effect of cross-level interaction between individual and neighborhood socioeconomic status on adult mortality rates. *Journal Information, 96*(12).

Wood, L., Shannon, T., Bulsara, M., Pikora, T., McCormack, G., & Giles-Corti, B. (2008). The anatomy of the safe and social suburb: An exploratory study of the built environment, social capital and residents' perceptions of safety. *Health & Place, 14*(1), 15-31. doi: http://dx.doi.org/10.1016/j.healthplace.2007.04.004

Yen, I. H., & Kaplan, G. A. (1998). Poverty area residence and changes in physical activity level: evidence from the Alameda County Study. *American journal of public health, 88*(11), 1709-1712.

Yen, I. H., Michael, Y. L., & Perdue, L. (2009). Neighborhood environment in studies of health of older adults: a systematic review. *American journal of preventive medicine, 37*(5), 455-463.

Ziersch, A. M., Baum, F. E., MacDougall, C., & Putland, C. (2005). Neighbourhood life and social capital: the implications for health. *Social science & medicine, 60*(1), 71-86. doi: http://dx.doi.org/10.1016/j.socscimed.2004.04.027